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Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics. **3958**

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Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation. **3994**

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Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation. **4008**

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Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations. **4019**

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Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles. **4138**

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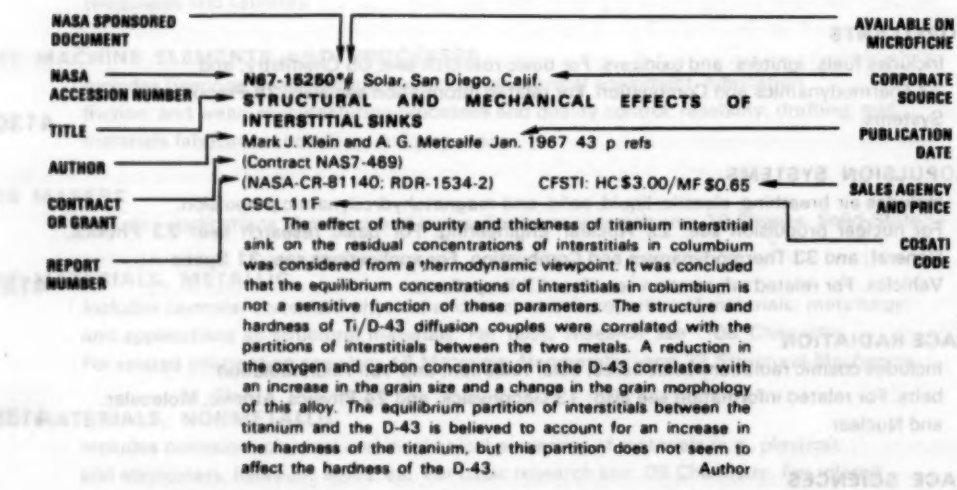
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STRUCTURAL AND MECHANICAL EFFECTS OF INTERSTITIAL SINKS
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Mark J. Klein and A. G. Metcalfe Jan. 1967 43 p refs
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The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium, but this partition does not seem to affect the hardness of the D-43.
Author

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Scientific and Technical Aerospace Reports

A Semimonthly Publication of the National Aeronautics and Space Administration

01 AERODYNAMICS

Includes aerodynamics of bodies, combinations, internal flow in ducts and turbo machinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion.

N67-36705* Scientific Translation Service, La Canada, Calif.
AERODYNAMIC DESIGN OF A HIGHLY EFFICIENT PROPELLER BLADE [AERODYNAMICKY NAVRH VRTULOVEHO LISTU S VYSOKOU UCINNOSTI]
Vaclav Broz Washington, NASA, Sep. 1967 26 p refs Transl. into ENGLISH from Zpravodaj VZLU (Letnany), no. 5, 1966 p 21–31
(Contract NASw-1496)
(NASA-TT-F-11218) CSCL 01A

A method is described for designing propeller blades with maximum aerodynamic efficiency. The technique is based on the vortex theory, the principal relations of which are described in detail. Primary consideration is given engine power, propeller diameter, forward velocity, and the number of propeller revolutions. Using these values, the power coefficient and the speed ratio are calculated to determine maximum propeller efficiency with a given propeller depth and local angle setting. Since these design parameters are dependent on local circulation, primary consideration is given to determining the optimum circulation distribution. The maximum efficiency problem is formulated and solved for the optimum circulation distribution. An iteration method is described for cases of forward flight and in-place running. The case of a slightly loaded propeller during forward flight is also analyzed, and a linearized solution for the circulation distribution is given. Author

N67-36884 Aeronautical Research Council (Gt. Brit.).
AN EXPERIMENT IN TURBINE BLADE PROFILE DESIGN
I. H. Johnston and Dianne Smart 1967 69 p refs
(ARC-CP-941)

Part I of this report describes a method for designing the blades of highly loaded two-stage turbine on the basis of certain design parameters derived from an efficient turbine of lower loading. Part II presents the test performances measured with the original and new blades when tested in both single-stage and two-stage configurations. A full and detailed presentation of the experimental work is given to illustrate the problems in instrumentation and in interpretation of test measurements which were encountered. The new blades give an improvement in the efficiency of the first stage, but the performance of the second stage remains unchanged and an analysis of blade section velocity distributions gives additional proof of the shortcomings of an essentially empirical design approach. Author

N67-36885 Aeronautical Research Council (Gt. Brit.).
THE LIFT AND DRAG CHARACTERISTICS OF CARET WINGS AT MACH NUMBERS BETWEEN 5 AND 10
J. R. Collingbourne and D. H. Peckham 1967 104 p refs
(ARC-CP-930)

The broad effects of certain variables on the aerodynamic efficiency of caret wings are investigated. The variables considered are slenderness ratio, volume coefficient and upper surface incidence; skin friction, including the effects of wing loading, altitude and transition Reynolds number; and parasite drag. This study highlights the important areas for future investigation, and recommendations are made for experimental and theoretical work. Author

N67-36940# Naval Ship Research and Development Center, Washington, D. C. Aerodynamics Lab.
POWERED MODEL INVESTIGATION OF THE EFFECTS OF GATED SPOILERS ON THE AERODYNAMIC CHARACTERISTICS OF WINGS AT ANGLES OF ATTACK FROM 0° TO 90°
Kenneth R. Reader and Richard D. Murphy Apr. 1967 59 p refs
(NSRDC-2406; NSRDC-Aero-1132; AD-655248)

An investigation was conducted to evaluate the effects of a gated spoiler near the upper surface leading edge of a propeller powered wing model. The device was considered appropriate for solution of a particular handling qualities problem in tilt-wing V/STOL aircraft that is related to wing stall phenomena. The data gathered indicate that a descending-decelerating approach of perhaps 20 degrees may be possible with the spoiler system. The most significant aspect of the benefits of the subject spoiler lies in the probable high insensitivity to wing planform (aspect ratio) which will allow freedom in the optimization of wing design. Author (TAB)

N67-37039 Aeronautical Research Council (Gt. Brit.).
TESTS WITH A TWO-DIMENSIONAL INTAKE HAVING ALL-EXTERNAL COMPRESSION AND DESIGN MACH NUMBER OF 2.2

M. C. Neale and P. S. Lamb London, HMSO, 1967 15 p refs Supersedes NGTE-M-383; ARC-26125
(ARC-CP-939; NGTE-M-383; ARC-26125) HMSO: 4s

Tests were conducted at a Mach number of 2.23 and at a Reynolds number, based on free stream conditions and intake capture height, of approximately 1×10^6. A stable critical flow could only be achieved when the intake was pitched slightly, relative to the free stream, in the direction tending to increase the deflection generated by the ramp. It is thought that the principal effect of applying the pitch was to move the ramp shocks forward from the cowl tip. At 2° pitch a pressure recovery of 89.9 percent was obtained with 6-1/2 percent bleed. With oly 2.4 percent bleed, the pressure recovery was 88.3 percent. Author

N67-37040 Aeronautical Research Council (Gt. Brit.). Aeronautical Research Council.
A USE OF ARBITRARY MODES IN CONTROL-SURFACE FLUTTER INVESTIGATIONS
LI. T. Niblett London, HMSO, 1967 15 p refs Supersedes RAE-TR-148; ARC-17826
(ARC-CP-928; RAE-TR-148; ARC-17826) HMSO: 3s

A method of determining the kind of distortion modes of an aircraft that are likely to lead to control-surface flutter is described. Arbitrary modes of flexure and torsion are selected and, for given critical flutter speeds and frequencies, the flutter equations are solved for the amplitude ratio between the arbitrary modes and the frequency of the resulting composite mode. The method has been used in an accident investigation to indicate the type of flutter that might ensue from a structural weakening of the wing. The method may also have useful applications in design. Author

N67-37046# Aeronautical Research Council (Gt. Brit.).
SOME EXACT CALCULATIONS OF THE LIFT AND DRAG PRODUCED BY A WEDGE IN SUPERSONIC FLOW, EITHER DIRECTLY OR BY INTERFERENCE
P. L. Roe London, HMSO, 1967 18 p refs Supersedes RAE-TN-2981; ARC-26437
(ARC-R&M-3478) HMSO: 8s

Exact inviscid theory is applied to a simple lifting configuration consisting of a wedge beneath a plane wing, both the wedge and the wing being terminated by a trailing edge which lies along a Mach cone. The efficiency of such an arrangement is compared with the efficiency of a wedge producing lift directly through incidence, as in the Nonweiler wing. The comparison is favourable to the interference arrangement provided the parameter $M_\infty^4 C_L/\beta_\infty^3$ is less than 0.65. In an Appendix it is shown that optimising the shape of the trailing edge makes the indirectly lifting wedge superior to the directly lifting wedge for values of $M_\infty^4 C_L/\beta_\infty^3$ between zero and unity. Author

N67-37105 Aeronautical Research Council (Gt. Brit.).
MORE TESTS WITH A VARIABLE RAMP INTAKE HAVING A DESIGN MACH NUMBER OF 2.2
M. C. Neale and P. S. Lamb London, HMSO, 1967 37 p refs Supersedes NGTE-M-370; ARC-25772
(ARC-CP-938; NGTE-M-370; ARC-25772) HMSO: 7s 6d

Results are reported of tests on a two-dimensional combined external/internal compression intake having a design Mach number of 2.2. Parameters investigated were: sidewall bleed, a 3 to 1 range of free stream Reynolds number, the length of subsonic diffuser, and sidewalls cut back to the line of the second ramp shock. The maximum pressure recovery obtained at the design Mach number was 90.9 percent with 6.4 percent bleed. A better performance was a pressure recovery of 90 percent with only 3.4 percent bleed. These figures were obtained at a Reynolds number, based on free stream conditions and intake capture height, of 3.25×10^6. It is possible that these pressure recoveries are close to the maximum attainable at Mach 2.2 in a mixed compression intake of acceptable mechanical complexity, and employing a simple four shock system. Author

N67-37181# Aeronautical Research Council (Gt. Brit.).
COMPARATIVE NUMERICAL APPLICATIONS OF THE REVERSE-FLOW THEOREM TO OSCILLATING WINGS AND CONTROL SURFACES
Doris E. Lehrian and H. C. Garner London, HMSO, 1967 45 p refs Supersedes ARC-27166
(ARC-R&M-3488; ARC-27166) HMSO: 18s

The reverse-flow theorem gives alternative expressions for generalized forces on oscillating wings. Relations for plunging and pitching derivatives are deduced for general and low frequencies. By a reverse-flow approach, wings with oscillating control surfaces are represented by smooth equivalent upwash functions. Illustrative examples indicate the reliability of solutions by numerical lifting-surface methods for various Mach numbers, frequencies, and wing-control-surface configurations. Author

N67-37201# Aeronautical Research Council (Gr. Brit.).
WIND TUNNEL TESTS ON A STREAMLINED FAN-LIFT NACELLE. PART I: TESTS ON NACELLE ALONE AND WITH WINGS OR UNDERFINS FITTED PART II: THE EFFECT OF FORWARD SPEED ON THE LIFT PRODUCED BY A LIFTING FAN AND ITS INLET
J. E. Hackett London, HMSO, 1967 51 p refs Supersedes NPL-AERO-1152; NPL-AERO-1170; ARC-26969; ARC-27330
(ARC-R&M-3470; NPL-AERO-1152; NPL-AERO-1170; ARC-26969; ARC-27330) HMSO: £1

Part I describes tests on a streamlined body with a lifting fan mounted normally to its axis. Most of the tests were made in the 5 ft×4 ft wind tunnel at Imperial College, and others in the No. 1 11-1/2 ft×8-1/2 ft tunnel at R.A.E. Farnborough. Comments are made on model design and engineering. Three component balance measurements and flow visualization were carried out over a range of ±20° incidence at speeds from 15 to 65 percent of the jet velocity, keeping fan r.p.m. constant. Comparison between tunnels showed important differences at high incidences and high forward speeds (18° and $V/V_j=0.6$) but 2 to 3 percent or less at lower speeds and incidences. Part II analyses in more general terms the way in which forward speed changes affect the lifting unit and the forces on it and examines the properties of hypothetical lifting units which have constant pressure and constant volume characteristics. The former is found to have some desirable features. The analysis is then applied to the experimental results from Part I, showing that, at a typical transition speed, a 5 percent lift loss due to fan-mainstream interaction is less significant than, say, the addition of underfins which influence the efflux-mainstream interaction. Author

N67-37203# Aeronautical Research Council (Gr. Brit.).
SOME MUTUAL INTERFERENCE EFFECTS BETWEEN A 5.7° CONE AND A SONIC-LEADING-EDGE DELTA WING AT $M^\infty = 2.49$
E. L. Goldsmith and P. H. Cook London, HMSO, 1967 53 p refs Supersedes RAE-TN-AERO-2936; ARC-25989
(ARC-R&M-3433; RAE-TN-AERO-2936; ARC-25989) HMSO: £1 1s

An arrangement of two parallel stings, one translating vertically and the other longitudinally, in a common housing has enabled measurements to be made of forces on a sonic-leading-edge delta wing in the presence of varying amounts of the flow field from a 5.7° semi-angle cone and vice versa. Measurements of lift, drag and pitching moment on each body were made at a Mach number of 2.49 and a Reynolds number of 3.04×10^6 (based on body length). Comparisons have been made with linear theory

calculations and indicate fair agreement as regards the effects of the body pressure field on the wing at zero and positive incidences. The buoyancy and downwash effects of the wing pressure field on the body are less well predicted. Author

N67-37463# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
ROTOR AIR-LOADS, BLADE MOTION, AND STRESS CAUSED BY TRANSIENT INPUTS OF SHAFT TORQUE AS RELATED TO STOPPABLE ROTOR OPERATION
L. Segel May 1967 146 p refs
(Contract DA-44-177-AMC-77(T))
(CAL-BB-1840-S-2; USAAVLABS-TR-67-18; AD-655268)

The transient-response calculation method is extended to yield aerodynamic loadings and elastic-blade motions in response to changes of shaft torque input. Loadings, bending moments, and modal responses are obtained for a teetering rotor experiencing both a 100- and a 50-percent power loss. Similarly, responses are computed for a hingeless rotor experiencing a 100-percent power loss and for a hingeless rotor being braked from an initial operational condition corresponding to 100-percent rpm and a nominal value of zero lift. This hingeless rotor is also started up from a stopped position. Examination of the results obtained in these computations indicates that (1) reasonable aerodynamic loadings can be predicted irrespective of the radial to tangetial velocity ratio and (2) no loading or structural response phenomena result in the examined flight condition which would indicate that power loss, braking, and rotor stopping have serious consequences with respect to the creation of unusual blade-wake interaction phenomena. Author (TAB)

N67-37568*# Martin Co., Baltimore, Md.
EXPLORATORY INVESTIGATIONS OF THE EFFECTS OF GAS INJECTION THROUGH A POROUS MODEL ON SEPARATION, TRANSITION, STATIC STABILITY AND CONTROL EFFECTIVENESS OF A BLUNT ENTRY BODY AT MACH NUMBER 7.3
Mark V. Morkovin and John C. Donohoe Jul. 1967 61 p refs
(Contract NAS2-3873)
(NASA-CR-73121) CSCL 01A

An exploratory research program to determine the effects of gaseous injection from the wall of a blunted entry body has been completed. Wind tunnel tests were made in the NASA 3.5-foot Hypersonic Wind Tunnel at Mach 7.3 and a nominal Reynolds number (based on length) of 0.48 million, using a porous stainless steel model. By metering room and low temperature nitrogen through the permeable model shell, model wall-to-stagnation temperature ratios from 0.08 to 0.35 were achieved. The mass rate parameter, $\dot{m}$ (ratio of injected mass to the product of free stream velocity, density and body base area), was varied from zero to 0.05. The location of separation and transition was judged from extensive spark shadowgraphs and from measurements of pressures, temperature and heat flux rates at the surface of the porous model just upstream of the 1.6 aspect ratio trailing edge flap. For zero flap deflection, the effect of wall blowing on the external aerodynamics was found to be very much smaller than on sharp nose bodies of comparable base area. For finite flap deflections, the separation pocket and associated force fields seem to be governed by the lateral venting of the pocket at the base of the flap, by the magnitude of the favorable pressure gradient upstream of the flap, and by the backpressure due to the flap. The effect of mass injection and cooling play a secondary role, especially at higher angles of attack. Similarly, the onset of large-scale instability of the separated pocket when the flap protrudes sufficiently through the bow shock wave is not hastened nor aggravated by the mass injection. Author

N67-37598* General Electric Co., Lynn, Mass. Flight Propulsion Div.
SINGLE STAGE EXPERIMENTAL EVALUATION OF HIGH MACH NUMBER COMPRESSOR ROTOR BLADING. PART 3: PERFORMANCE OF ROTOR 2E
J. P. Gostelow and K. W. Krabacher 29 Sep. 1967 81 p refs
(Contract NAS3-7617)
(NASA-CR-54583; GER-67FPD248) CSCL 10A

A rotor with a 1400 ft/sec tip speed and a 0.5 hub-tip radius ratio, designed to deliver a total pressure ratio of 1.76 and a rotor adiabatic efficiency of 0.837 at a flow of 215.49 lbs/sec, was tested with an undistorted inlet. For conditions at design speed, judged to have adequate stall margin for engine operation, a total-pressure ratio of 1.711 and an adiabatic efficiency of 0.869 were achieved at a flow of 225.9 lbs/sec. The peak adiabatic efficiency of 0.884 at design speed occurred close to the stall line. Author

N67-37623 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
RECENT DEVELOPMENTS IN WIND-TUNNEL MEASUREMENTS OF AERODYNAMIC CERIVATIVES [PROGRES REALISES DANS LES TECHNIQUES DE MESURE DES DERIVEES AERODYNAMIQUES EN SOUFFLERIE METHODE D'OSCILLATIONS FORCEES]
Michel Scherer and Joseph Lopez 1966 32 p refs In FRENCH; ENGLISH summary Presented at the Reunion of AGARD on Stability and Piloting, Cambridge, Mass., 20–23 Sep. 1966
(TP-389(1967))

Some of the most important unsteady-testing devices used in wind-tunnels are presented. These devices give the complete set of derivatives, the knowledge of which is necessary to the study of flight mechanics of planes or missiles. The tests can be carried out in continuous or in intermittent wind-tunnels. Sting dynamometers and microaccelerometers equipped with silicium strain-gages are now employed. An example is given for comparison of the wind-tunnel measurements; it deals with the measurement in flight and in wind-tunnel of the STOL-Breguet 941 in landing a configuration. Author

N67-37637# Aeronautical Research Council (Gt. Brit.)
THE CALCULATION OF THE WARP TO PRODUCE A GIVEN LOAD AND THE PRESSURES DUE TO A GIVEN THICKNESS ON THIN SLENDER WINGS IN SUPERSONIC FLOW
J. H. B. Smith, J. A. Beasley, Diana Short and F. Walkden 1967 38 p refs Supersedes RAE-TR-65260; ARC-27547
(ARC-P&M-3471; RAE-TR-65260; ARC-27547) HMSO: 13s 6d

According to the linearized theory of supersonic flow, both the local slope of the mean surface of a wing producing a specified distribution of lift and the pressure on a wing due to a specified distribution of volume are given as singular double integrals. The numerical evaluation of these integrals is described for planforms with curve subsonic leading edges and supersonic trailing edges. Examples are given illustrating the use of these methods in the design of slender wings. Author

N67-37680 Aeronautical Research Council (Gt. Brit.)
SOME TESTS WITH A VARIABLE RAMP INTAKE HAVING SIDEWALL COMPRESSION AND A DESIGN MACH NUMBER OF 2.2
M. C. Neale and P. S. Lamb 1967 19 p refs Supersedes NGTE-M-367; ARC-25268
(ARC-CP-936; NGTE-M-367; ARC-25268) HMSO: 4s

Results are reported of some tests aimed at determining the effect of sidewall compression in a "two dimensional" intake having combined external/internal compression and a design Mach

number of 2.2. Sidewall compression results from the chamfers that are necessary to provide thickness for the splitter plate separating the two units of a twin cell intake. The results suggest that the maximum penalty likely to result from the introduction of sidewall compression will be about 1 percent on pressure recovery. With further development the penalty may be eliminated. Author

N67-37735# Aeronautical Research Council (Gt. Brit.).
ESTIMATES OF THE LIFT REDUCTION DUE TO BOUNDARY LAYER ON TWO-DIMENSIONAL AEROFOILS
J. A. Beasley 1967 21 p refs Supersedes RAE-TR-64014; ARC-26556
(ARC-R&M-3442; RAE-TR-64014; ARC-26556) HMSO: 9s

Experimental values of the reduction in lift curve slope due to boundary layer on two-dimensional aerofoils in incompressible flow are compared with estimates derived from the Royal Aeronautical Society Data Sheet and estimates calculated by Spence's theoretical method. The Data Sheet is shown to underestimate the lift slope in some cases where transition is not fixed at the leading edge and it is suggested that this is due to the effect upon lift of the movement of transition position with incidence. It is proposed that the Data Sheet should be modified to indicate the limiting values between which the slope of the lift curve should lie. No more accurate method of assessing the effect of transition movement seems possible but it is thought that the uncertainty will be small in full scale practical cases. Author

N67-37783# Sandia Corp., Albuquerque, N. Mex.
STABILITY AND AXIAL FORCE TESTS OF THE STANDARD HYPERVELOCITY BALLISTIC MODELS HB-1 AND HB-2 AT MACH NUMBERS OF 5.3, 7.5, AND 11.4
William A. Millard May 1967 31 p refs
(Contract AT(29-1)-789)
(SC-RR-67-176) CFSTI: HC $3.00/MF $0.65

The Supersonic Tunnel Association standard hypervelocity ballistic correlation Models HB-1 and HB-2 were tested in the Sandia Laboratory 18-inch Hypersonic Wind Tunnel to determine the static stability and axial force coefficients at M = 5.3, 7.5, and 11.4. These results are compared with force data obtained for similar models in the AEDC wind tunnels. The comparisons indicated only relatively minor discrepancies between the data from the two facilities. Author (TAB)

N67-38016*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A NUMERICAL METHOD FOR STUDYING THE TRANSIENT BLADE MOTIONS OF A ROTOR WITH FLAPPING AND LEAD-LAG DEGREES OF FREEDOM
Julian L. Jenkins, Jr. Washington, NASA, Oct. 1967 35 p refs
(NASA-TN-D-4195) CFSTI: HC $3.00/MF $0.65 CSCL 01A

The equations of motion for the fully articulated rotor system (i.e., rigid blade with flapping and lead-lag degrees of freedom) are derived and the procedure used to obtain a numerical solution of the nonlinear coupled equations of motion is outlined. The equations can be applied to a rotor system with blades of any airfoil section, mass distribution, twist, taper, and root cutout. The hinge geometry is variable; however, the restraints considered require that the lag hinge be coincident with or outboard of the flapping hinge. Two-dimensional stall and compressibility effects can be accounted for. Stability boundaries are defined in terms of an absolute limit (i.e., hinge motion amplitudes greater than 90°) for varying blade mass constants as a function of the initial azimuth position for introducing a disturbance. In addition, a boundary is presented which is based on the criterion of neutral spring forces in the forward quadrants of the rotor when the blade is released with an initial flapping-angle displacement at an initial azimuth angle of 90°. This boundary is thus a measure of the tip-speed ratio at which the nonlinear spring forces in the forward quadrants are approximately zero. A comparison of this boundary with one based on a maximum flapping amplitude limit of 15° for a 30-ft/sec (9.14-m/sec) vertical gust indicates good correlation. Author

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N67-36714# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
A COMPARISON OF COCKPIT WARNING SYSTEMS
Almon J. Bate and Charles Bates, Jr. Apr. 1967 30 p refs
(AMRL-TR-66-180; AD-655772)

The experiment was designed to compare three types of aircraft cockpit warning systems: (1) Visual: malfunctions simultaneously activated a master warning light and a specific malfunction indicator light. (2) Visual and tone: malfunctions simultaneously activated an intermittent sweeping tone (through earphones), a master warning light, and a specific malfunction indicator light. (3) Visual and voice: malfunctions simultaneously activated a master warning light, a specific malfunction indicator light, and a voice recording which informed the operator through his earphones of the specific malfunction needing attention. Three groups of 11 university students served as subjects. While responding to a visual, visual-tone, or visual-voice warning system, each subject was also required to find and position, under cross hairs, a series of strategic targets on a strip of rear-projected aerial photographic imagery. No statistically significant differences among the three warning systems were found in the speed of reaction to the master warning light, reaction to the specific-indicator panel, total reaction time, or number of strategic targets found or missed. The results of the study suggest that the addition of either a tone or a voice warning to a visual, master plus specific, malfunction warning system is of questionable value in a heads-in cockpit situation where the visual system can be seen. The data from the experiment do not suggest that a voice warning system has any advantage over a simple aural signal for augmenting a visual system. Author (TAB)

N67-36725*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC AERODYNAMIC CHARACTERISTICS OF THREE RAM-AIR-INFLATED LOW-ASPECT-RATIO FABRIC WINGS
Sanger M. Burk, Jr. and George M. Ware Washington, Sep. 1967 34 p refs
(NASA-TN-D-4182) CFSTI: HC $3.00/MF $0.65 CSCL 01A

A study of the low speed static aerodynamic characteristics of three ram-air-inflated low-aspect-ratio fabric wings was made in the Langley full-scale tunnel. The wings which were rectangular in planform and had an airfoil-shaped cross section were open at the nose to allow air to enter and inflate the wings; the payload was suspended on lines below the wings. Effects of four different test setups were also determined. Results indicated that the

untrimmed maximum lift–drag ratios of the wings ranged from 1.9 to 2.7 and that the untrimmed maximum lift coefficients varied from about 0.9 to 1.1. Results of tests of two of the wings selected for a study of their stability characteristics indicated that they were statically longitudinally stable over the entire test angle-of-attack range of 0° to 70° except for a slight unstable break in the pitching-moment curves at angle of attack just beyond that for the stall. Both of these wings had generally satisfactory static lateral stability characteristics over the entire test angle-of-attack range. Author

N67-36760# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AERODYNAMIC EXPERIMENTS ON AIRCRAFT
Meu-Sing Liu 31 Jan. 1967 11 p Transl. into ENGLISH from Hang K'ung Chih Shih, no. 4, 1964 p 28–30
(FTD-TT-65-1824; TT-67-62356; AD-655357)

A non-technical article is presented explaining the usefulness and importance of aerodynamic experimentation. The paper gives general descriptions of the domains of aerodynamic experiments and the approaches to the measurement of aerodynamic forces. In discussing the methods for carrying out the experimental studies, the report gives brief descriptions of several modern research tools and techniques which include wind tunnels, pilotless electronic-controlled flying models, rocket trains and test pilot flying experiments. TAB

N67-36765# Stanford Research Inst., Menlo Park, Calif.
SONIC BOOM EXPERIMENTS AT EDWARDS AIR FORCE BASE
Arlington, Va., Natl. Sonic Boom Evaluation Office, 28 Jul. 1967 410 p refs
(Contract AF 49(638)-1758)
(NSBEO-1-67; AD-655310)

A series of tests was conducted in which human subjects (located indoors and outdoors), special test structures, and animals were exposed to booms from F-104, F-106, B-58, SR-71, and XB-70 supersonic aircraft, and the noise from KC-135 and WC-135B subsonic aircraft. Physical measurements were made of the sonic boom signatures, subsonic aircraft noise, and the response of structures to the booms and noise. Psychological measurements were made of the subjective acceptability to several hundred subjects of the booms and subsonic aircraft noise. Details of the test plan and procedures, and the results of the data analyzed to date are presented. Author (TAB)

N67-36886 Aeronautical Research Council (Gt. Brit.).
COMPUTER PROGRAMMES TO CALCULATE THE RESPONSE OF FLEXIBLE AIRCRAFT TO GUSTS AND CONTROL MOVEMENTS
C. G. B. Mitchell 1967 56 p refs
(ARC-CP-957)

The equations of motion for flexible aircraft with or without automatic control systems exposed to excitation by harmonic gusts or control movements are given. The response to transient excitation of step form is found by a Fourier transform process. Computer programs to solve these equations are described, together with supporting data preparation and analysis programs. Manual data preparation is minimized. Detailed program specifications are given in appendices. Author

N67-36931 Aeronautical Research Council, Gt. Brit.
"ZERO RATE OF CLIMB SPEED" AS A LOW SPEED LIMITATION FOR THE STALL-FREE AIRCRAFT
W. J. G. Pinsker 1967 24 p
(ARC-CR-931)

An attempt is made to assess the significance to flight safety of a condition at low speeds where drag exceeds the available engine thrust. For the low aspect ratio aircraft and especially with slender wing designs having practically no stall, the zero rate of climb speed defined by the condition may constitute the lowest limit of the practical speed range. Methods are suggested to assess the necessary margins to protect aircraft of this general class against the accidental, possibly catastrophic, loss of performance below this speed. Author

N67-36983# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
FLIGHT INVESTIGATION OF LONGITUDINAL SHORT PERIOD FREQUENCY REQUIREMENTS AND PIO TENDENCIES Final Report
Dante A. Di Franco Wright-Patterson AFB, Ohio, AF Flight Dyn. Lab., Jun. 1967 154 p refs
(Contract AF 33(615)-2536)
(CAL-TC-2083-F-1; AFFDL-TR-66-163; AD-656784)

The results of a flight test program to investigate longitudinal short period frequency requirements and PIO (pilot-induced oscillation) tendencies are presented and discussed. Short period frequency requirements were investigated with a damping ratio of approximately 0.7 at three fixed values. PIO tendencies were investigated with various values. The feel system dynamic characteristics were held essentially constant throughout the program. A variable stability T-33 airplane was used as an in-flight simulator. Each configuration was evaluated as a fighter in up and away flight. The evaluation pilots commented on each configuration and rated each numerically. An analysis of pilot ratings and pilot comments was made, and these in turn were related to various handling qualities parameters. In the analysis and interpretation of the handling qualities results, feel system dynamics and pilot-selected stick force gradients were also important considerations. Author (TAB)

N67-36990 Aeronautical Research Council (Gt. Brit.).
A REVIEW OF COUNTING ACCELEROMETER DATA ON AIRCRAFT GUST LOADS
N. I. Bullen London, HMSO, 1967 43 p refs Supersedes RAE-TR-66234; ARC-28702
(ARC-CP-933; RAE-TR-66234; ARC-28702) HMSO: 9s 6d

Counting accelerometer data collected over a period of several years on a number of passenger transport aircraft are summarized and the derived gust frequency distributions studied. The intensity of the turbulence encountered is compared with that observed by research aircraft in storms and clear air. Author

N67-36987# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.
ECONOMIC AND TECHNICAL FEASIBILITY ANALYSIS OF ESTABLISHING AN ALL WEATHER V/STOL TRANSPORATION SYSTEM
Joseph M. Del Balzo (M.S. Thesis—Drexel. Inst. of Tech.) May 1967 140 p refs
(RD-67-36)

The need and potential of an aircraft having vertical and/or short take off and landing capability (V/STOL) is considered. The technical and economic feasibility of establishing an all weather V/STOL transportation system is explored. Traffic forecasts for the V/STOL for the years 1968 through 1980 are postulated. The enroute, terminal, and approach and landing navigation system requirements for the V/STOL are analyzed. Anticipated operating costs and revenue, based on an analysis of the New York–Boston air shuttle route, are presented. Author

N67-37002# Ryan Aeronautical Co., San Diego, Calif.
BOUNDARY LAYER CONTROL SYSTEM INSTALLATION FOR THE YCU-2B AIRPLANE Final Report
C. A. Cordner May 1967 203 p refs
(Contract DA-44-177-AMC-35(T))
(Rept.-65B017A; USAAVLABS-TR-66-33; AD-656480)

An investigation was made of the feasibility of installing a high lift boundary layer control (BLC) system in a YCV-2B airplane. Work was conducted to determine the feasibility and practicability of improvement of takeoff and landing performance of YCV-2B aircraft. Primary effort was directed to the development of a compressed air/gasoline fuel primary motor for driving the jet pump system. Secondary effort was directed to the design and evaluation of the system and to the performance characteristics. Also, smoke tunnel tests were conducted to determine qualitatively the effects of BLC on lift characteristics of the YCV-2B airfoils. Difficulty was experienced in the development of the primary motor owing to its inability to contain high temperatures. However, the experimental prototype model was satisfactory for obtaining limited jet pump data. The performance of the jet pump was not able to improve takeoff and landing characteristics of the aircraft. Design and technical analysis studies showed that the BLC system could not be installed and operated in the YCV-2B airplane with any reasonable expectancy of success. Included are equations, computer programs and methods for predicting design parameters, and performance characteristics of jet pumps and boundary layer controls systems. Author (TAB)

N67-37177# Aviation Safety Engineering and Research, Phoenix, Ariz.
CRASH SURVIVAL DESIGN GUIDE
J. W. Turnbow, D. F. Carroll, J. L. Haley, Jr., W. H. Reed, S. H. Robertson et al Jul. 1967 273 p refs
(Contract DA-44-177-AMC-360(T))
(AvSER-66-18; USAAVLABS-TR-67-22; AD-656621)

The report concerns the development of crashworthy U. S. Army aircraft. The guide presents in a condensed form the data, design techniques, and criteria which are presently available in eight areas: (1) Aircraft crash kinematic and survival envelopes; (2) airframe crashworthiness design criteria; (3) aircraft seat design criteria (crew and troop/passenger); (4) restraint system design criteria (crew, troop/passenger and cargo); (5) occupant environment design criteria; (6) aircraft ancillary equipment stowage design criteria; (7) emergency escape provisions; (8) postcrash fire design criteria. Author (TAB)

N67-37202# Aeronautical Research Council (Gr. Brit.).
THE LONGITUDINAL RESPONSE OF A FLEXIBLE SLENDER AIRCRAFT TO RANDOM TURBULENCE
E. Huntley London, HMSO, 1967 45 p refs Supersedes RAE-AERO-2691; ARC-26674
(ARC-R&M-3454; RAE-AERO-2691; ARC-26674) HMSO: 18s 6d

The responses of a slender supersonic transport aircraft flying through random turbulence have been evaluated for the cruise condition. The problem was simplified by assuming that the aircraft responds only in heave, pitch and longitudinal bending as defined by the fundamental normal mode and by using piston theory aerodynamics. The results show that the c.g. normal acceleration response is very dependent on the pitching degree of freedom but is relatively little affected by flexibility. Flexibility does have an important effect on normal acceleration at the aircraft nose, where it increases the r.m.s. value by a factor of 2.2, but has negligible effect over the rear 70% of the aircraft length. It is shown that strains occurring in the fundamental mode can be correlated with c.g. accelerations, the factor relating them being 1.37 times the strain per g that would be measured in a steady pull-out. Author

N67-37285*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SIMULATOR INVESTIGATION OF MANEUVER SPEED INCREASES OF AN SST CONFIGURATION IN RELATION TO SPEED MARGINS
Milton D. McLaughlin Washington, NASA, Oct. 1967 33 p refs
(NASA-TN-D-4085) CFSTI: HC$3.00/MF$0.65 CSCL 01C

A preliminary investigation has been made of airspeed increases from upsets in pitch, push-overs, longitudinal trim runaways, and abandons of controls and simulated operations in the air traffic control (ATC) system for a generalized double-delta supersonic transport (SST) configuration for the purpose of assessing the overspeeding in relation to the tentative speed margin. A piloted fixed-base aircraft simulator was used in the investigation. Tests were made for climb, level flight, and descent conditions along the maximum operating limit speed profile. Results show that at supersonic speeds the 7.5° upset maneuver, currently proposed as a standard for establishing a speed margin, provided a margin greater than the speed excursions resulting from other maneuvers. The 7.5° upset maneuver, however, may be unsuitable for establishing overspeed criteria for the SST at supersonic speeds because of the increase in entry times over subsonic values. A constant acceleration push-over type maneuver appeared to be more rational at supersonic speeds. In operations in the simulated ATC system, the pilots recommended that, in order to avoid frequent overspeeds, the climb profile should be a minimum of at least 10 to 20 knots below the maximum operating limit speed. Author

N67-37312 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux
ANALYSIS OF THE STABILITY AND CONTROL OF AN AIRPLANE BEYOND MAXIMUM LIFT [ANALYSE DE LA STABILITE ET DE CONTROLE D'UN AVION AU DELA DE SA PORTANCE MAXIMALE]
Philippe Poisson-Quinton and Emile Erlich 1966 22 p refs In FRENCH; ENGLISH summary Presented at the Reunion of AGARD on Stability and Piloting, Cambridge, Mass., 20–23 Sep. 1966
(TP-387(1967))

The deep-stall corresponds to a trimmed and stable flight regime at a large angle-of-attack; this is a dangerous configuration generally found with rear-mounted turbojet T-tail airplanes. The incipient deep-stall is first reviewed and then the longitudinal trouble is analyzed using two typical configurations investigated in O.N.E.R.A. wind-tunnels: (a) a swept-wing transport including the effect of various positions of the nacelles and of the horizontal tail as well as of various fuselage shapes. (b) A variable-geometry airplane including the effect of various positions of the horizontal tail and of the different sweep angles of the wing. In both cases, we find that a T-tail may lead to a typical deep-stall preceded by a violent pitch-up. We also show that the longitudinal control surfaces are not sufficient to bring back the airplane in its normal flight attitude. Author

N67-37325# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
A METHOD FOR PREDICTING THE AERODYNAMIC LOADS AND DYNAMIC RESPONSE OF THE ROTOR BLADES OF A TANDEM-ROTOR HELICOPTER
John C. Balcerak Jun. 1967 91 p refs
(Contract DA-44-177-AMC-207(T))
(CAL-BB-1960-S-1; USAAVLABS-TR-67-38; AD-656755)

The blades of each rotor are represented by segmented lifting lines located at the quarterchord positions of the blades and the vortex strength is assumed to be constant over each segment of the blade at each of an arbitrary number of azimuth positions. The wake is represented by a mesh of shed and trailing vortex filaments up to an arbitrary finite distance behind each blade, and beyond this point the wake is represented by a segmented, tip-trailing vortex or by segmented, tip- and root-trailing vortices.

The aerodynamic loadings and the flapwise structural bending moments were computed for the CH 47A tandem-rotor helicopter for advance ratios of 0.08, 0.14 and 0.24. Comparisons of these results with measured results for individual test points are presented as radial distributions of the first three harmonic components and as time histories which include eleven harmonics. The measured data were generally presented in the form of typical results from a statistical sampling of measured data from similar test conditions. Author (TAB)

N67-37376# Federal Aviation Agency, Atlantic City, N. J. National Aviation Facilities Experimental Center.

A STUDY OF AIR TRANSPORT PASSENGER CABIN FIRES AND MATERIALS

John F. Marcy Dec. 1965 56 p refs
(FAA-ADS-44; AD-654542)

A study was made of the ignition and burning characteristics of materials used for the interior furnishings of passenger cabins. Materials were tested by several standard laboratory methods as well as in situ inside an airplane fuselage. Results of laboratory tests on specific materials were shown to be useful in predicting the degree of fire hazards present at various locations inside a cabin. The ability of the more flame-resistant materials, as determined in laboratory tests, to resist and contain the spread of fire was demonstrated in 40 cabin tests. The nature of catastrophic cabin fires resulting in flash fires was investigated by conducting two full-scale tests within a fuselage during which fire was permitted to continue burning to the point of extensive damage. Recordings of cabin temperature, smoke, oxygen depletion and carbon monoxide up to the time of the sudden occurrence of a flash fire were low compared to human survival limits. Author (TAB)

N67-37635# Naval Air Engineering Center, Philadelphia, Pa. Aeronautical Structures Lab.

STATISTICAL PRESENTATION OF NAVAL AIRCRAFT COUNTING ACCELEROMETER DATA FROM 1 JANUARY 1962 TO 1 OCTOBER 1966

William K. Ragan, Jr. 22 Jun. 1967 463 p refs
(NAEC-ASL-1108; AD-656589)

A summary of normal (vertical) acceleration data recorded by counting accelerometer groups at four preset levels is presented for 46 models of naval aircraft. The frequency of exceeding these load-factor levels is tabulated by model and by individual aircraft. Author (TAB)

N67-37653*# National Aeronautics and Space Administration, Washington, D. C.

HELICOPTERS CALCULATION AND DESIGN. VOLUME I: AERODYNAMICS

M. L. Mil' A. V. Nekrasov, A. S. Braverman, L. N. Grodko, and M. A. Leykand Sep. 1967 505 p refs Transl. into ENGLISH of the book "Vertolety. Raschet i Proyektirovaniye. I. Aerodinamika" Moscow, Izd. "Mashinostr." Publishing House, 1966
(NASA-TT-F-494) CFSTI: $3.00 CSCL 01C

A review of the historical development of Russian and Western helicopters, in size and lift capacity, for civil and military purposes is followed by detailed discussions on rotor aerodynamics for various angles of attack, blade setting, flapping angle, center-of-pressure position, blade vibration (natural, forced, harmonic, etc.), and other rotor parameters in their influence on rotor rpm and craft stability. Formulas are given for the forces and moments of rotor damping in hovering and forward flight; for the redistribution of aerodynamic forces over the rotor disk due to flapping; for cyclic pitch change of rotors with variable and constant pitch. The theory of an ideal helicopter is developed on the basis of optimum blade profile, prevention of rotor profile losses, and proper balancing. Flutter in hovering and forward flight is calculated, with emphasis on friction in the axial hub hinges and transfer of vibrations through the automatic pitch control. Author

N67-37674*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

INVESTIGATION OF PITCH MANEUVER SPEED MARGINS FOR A SUPERSONIC TRANSPORT CONFIGURATION WITH A VARIABLE-SWEEP WING

Richard H. Sawyer, Milton D. McLaughlin, and Norman S. Silsby Washington, NASA, Oct. 1967 17 p refs
(NASA-TN-D-4170) CFSTI: HC $3.00/MF $0.65 CSCL 01C

Investigated were speed and altitude excursions for 0.5g pushover and 7-1/2° upset-in-pitch maneuvers for a supersonic transport (SST) configuration with a variable-sweep wing in order to establish speed-margin requirements. A piloted fixed-base aircraft simulator was used to test level, climbing, high-speed descent, and emergency-descent flight conditions. At subsonic speeds, a 10-second 0.5g pushover maneuver provided about the same speed margin between maximum operating speed and design dive speed as a 7-1/2° 20-second upset maneuver with the wings swept to either the 42° or 72° positions. Over the supersonic speed range below conditions at which the aircraft is Mach-limited, the speed margins for each of the 10-, 15-, and 20-second 0.5g pushover maneuvers were approximately constant, in contrast to the speed margin for the 7-1/2° upset maneuver which increased greatly with increase in speed. Over this speed region, the speed margin for the 10-second 0.5g pushover maneuver generally exceeded the speed margin for the "miscellaneous causes" requirement. Over the Mach-limited flight region, the speed margin for the "miscellaneous causes" requirement exceeded the speed margins found for each of the 10-, 15-, and 20-second 0.5g pushover and the 7-1/2° 20-second upset maneuvers. Author

N67-37884# Royal Aircraft Establishment, Farnborough (England).

THE IMPLICATIONS OF ALL-WEATHER LANDING IN THE U.K.

O. B. St. John and R. C. Morgan (Brit. European Airways) Feb. 1967 34 p Presented at the 5th Congr. of the Intern. Council of Aeron. Sci., London, Sep. 1966
(RAE-TR-67032) CFSTI: HC $3.00/MF $0.65

All weather landing facilities and operations which are in use in the United Kingdom are reviewed; and suggested areas requiring further study as those related to low visibility conditions, are discussed. Emphasized is the need for further studies of: (1) the role of the pilot during low visibility landings, and (2) airfield environments which will enable a safe automatic landing in all weather conditions. S.C.W.

N67-37982 Commerce Dept., Washington, D. C.

SST AN ECONOMIC ANALYSIS. PART I: EXECUTIVE SUMMARY Preliminary Supplement II

[1967] 40 p
(AD-655605)

The question of program financing and control is discussed in three parts: (1) Alternative approaches, (2) Analysis of program risks, and (3) Design competition and product improvement. TAB

N67-38041# Advisory Group for Aerospace Research and Development, Paris (France).

A NEW TYPE OF MODULATOR FUNCTIONS FOR THE SHINBROT'S METHOD. EXPERIENCE WITH SHINBROT'S METHOD OF TRANSIENT RESPONSE ANALYSIS FOR THE EXTRACTION OF STABILITY AND CONTROL DERIVATIVES [UN NOUVEAU TYPE DE FONCTIONS MODULATRICES POUR LA METHODE DE SHINBROT]

J. Pere (Sud-Aviation) and B. R. A. Burns (British Aircraft Corp.) 1966 51 p refs In FRENCH and ENGLISH
(AGARD-549, Pt. II)

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N67-38042# Advisory Group for Aerospace Research and Development, Paris (France).

A NEW TYPE OF MODULATOR FUNCTIONS FOR THE SHINBROT'S METHOD [UN NOUVEAU TYPE DE FONCTIONS MODULATRICES POUR LA METHOD DE SHINBROT]

J. Pere (Sud-Aviation) *In its* A New Type of Modulator Functions for the Shinbrot's Method. Experience with Shinbrot's Method of Transient Response Analysis for the Extraction of Stability and Control Derivatives 1966 p 1–16 refs (See N67-38041 22-02)

Shinbrot's method, using modulator functions for the analysis of aerodynamic responses in flight mechanics had presented difficulties of application when used in its original form. The method was therefore re-examined and the presentation modified. This study, undertaken in June 1965 at the request of the Flight Test Center, Istres and the Flight Test Directorate of Sud-Aviation, Toulouse gave excellent results when applied to investigation of the aerodynamic coefficients of the Mirage III aircraft. Author

N67-38043# Advisory Group for Aerospace Research and Development, Paris (France).

EXPERIENCE WITH SHINBROT'S METHOD OF TRANSIENT RESPONSE. ANALYSIS FOR THE EXTRACTION OF STABILITY AND CONTROL DERIVATIVES

B. R. A. Burns (British Aircraft Corp.) *In its* A New Type of Modulator Functions for the Shinbrot's Method. Experience with Shinbrot's Method of Transient Response Analysis for the Extraction of Stability and Control Derivatives 1966 p 17–35 refs (See N67-38041 22-02)

The reasons for using transient response analysis technique for the extraction of stability and control derivatives from flight records on an autostabilized aircraft are stated. Test and analysis methods are reviewed briefly and reasons for adopting the method of Shinbrot (NASA TN 3288) are discussed. A brief description of Shinbrot's technique follows and the method of application, including the representation of instrumentation dynamic response, in the equations of motion is discussed. Preliminary experience with the method, applied to the analysis of highly-damped responses recorded on a Meteor and a Dove with sensitive test instrumentation, is described. It is shown that, when all terms in the equations of motion were treated as unknowns, unreliable results were obtained. Good results were obtained only by reducing the number of unknowns in each equation of motion. Author

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N67-36708*# Bellcomm, Inc., Washington, D. C.

THE EFFECT OF LAUNCH TIME ON THE PERFORMANCE OF A SOLAR ARRAY/BATTERY ELECTRICAL POWER SYSTEM

W. W. Hough 11 Jul. 1967 35 p refs
(Contract NASw-417)
(NASA-CR-88404; TM-67-1022-3) CSCL 10A

An analytical treatment is made of continuous power output from a solar array battery system on a space vehicle in near earth orbit as a function of several variables. Among the variables are launch time, mission time and duration, flight attitude, and array orientation with respect to the spacecraft. This analysis was performed as part of a trade-off study on power system configuration vs. flight attitude for the Apollo Applications Missions 1 and 2. Statistical analyses of the minimum angle between the sun line and the orbital plane, β, and of continuous power outputs have yielded average values of these quantities over the course of missions launched at specific times. Maximums, minimums, means, and variances of these averages have been found to evaluate the power system capability for a random launch time. For a spacecraft stabilized by gravity-gradient torque, optimum fixed array orientations have been found as a function of β. Author

N67-36744# Marathon Battery Co., Wausau, Wis.

DEVELOPMENT OF IMPROVED ZINC BATTERIES FOR HIGH TEMPERATURE STORAGE Semiannual Report, 30 Sep. 1966–1 Jun. 1967

George H. Schroeder 1 Jun. 1967 46 p
(Contract DA-28-043-AMC-02534(E))
(ECOM-02534-1; SAR-1; AD-654471)

The report describes results obtained in an effort to improve the high temperature storageability of cylindrical zinc-MnO2 Le Clanche cells. Reference is made to the causes of break down at elevated temperatures as well as to the efforts made to eliminate them. TAB

N67-36755*# Radio Corp. of America, Moorestown, N. J.

PHASED ARRAYS FOR METEOROLOGICAL SATELLITE

Charles E. Profera, Jr. Jun. 1967 100 p refs
(Contract NAS12-149)
(NASA-CR-86000) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Multimode techniques have been applied to the design of an E-plane sectoral horn to produce tapered line source illuminations resulting in low-sidelobe patterns. An H-plane array of multimode horns can be combined through a multimode power combiner to provide a single-plane electronic scan capability. Basic design data for the multimode line source has been formulated and two array configurations considered. A parallel array of reduced-width multimode horns was evaluated for reduced bandwidth and scan capability. Pattern measurements in the plane of the line source revealed a negligible effect due to the presence of the dummy elements. An analysis was made to determine the effect of phase shifter errors on array patterns. The errors associated with a 5-bit phase shifter typically increase maximum computed sidelobes resulting in a decrease of beam efficiency. Author

N67-36782*# Allis-Chalmers Mfg. Co., Milwaukee, Wis. Research Div.

RESEARCH AND DEVELOPMENT OF OPEN-CYCLE FUEL CELLS Quarterly Progress Report, Feb. 16, 1965–May 15, 1965

R. Desai, G. Monette, and C. Williams 15 Jun. 1967 38 p refs
(Contract NAS8-5392)
(NASA-CR-88387; NAS8-5392-QPR-003; QPR-3) CSCL 10A

The computer program to optimize space radiators with respect to weight has been completed and design charts presented. The study of fuel cell startup techniques has been initiated and

the effect of temperature gradient on electrolyte concentration gradient determined. The revision and improvement in the computer program for the mathematical representation of the static vapor pressure method of water removal are described. The approaches to develop a mathematical model for cell degradation and to expand the reliability study of fuel cells are presented. Author

N67-36888*# Franklin Inst., Philadelphia, Pa. Research Labs.
SENSITIVITY EVALUATIONS OF THREE SQUIBS USED IN TEST VEHICLES AT THE GODDARD SPACE FLIGHT CENTER Final Report
Paul F. Mohrbach, Raymond R. Raksnis, and Raymond G. Amicone Apr. 1967 33 p
(Contract NAS5-3878)
(NASA-CR-88622; F-B2210-5) CSCL 10C

Test results on three electroexplosive devices used in the Delta Vehicle flights (Flare Northern, FND-209 Squib; the DuPont S-94 Squib; and the McCormick Selph Mc/S/A P/N 808098-1 Rev. A Squib) are presented. Static electricity, radio frequency sensitivity, and input impedance data are given. L.S.

N67-36909# Massachusetts Inst. of Tech., Cambridge. Center for Materials Science and Engineering.
INVESTIGATION OF A PIN-STRUCTURE GERMANIUM PHOTOVOLTAIC CELL Semiannual Report, 15 Jul. 1966–1 Feb. 1967
B. D. Wedlock, R. Siegel, C. R. Hewes, and D. L. Smythe Jun. 1967 95 p refs
(Contract DA-28-043-AMC-01978(E))
(ECOM-01978-2; AD-656619)

Several phenomena affecting the V-I characteristics of PIN thermophotovoltaic converter diodes are discussed, including diffused layer recombination, minority carrier injection, and non-planar effects. Analysis of the distributed resistance is developed to estimate the optimum converter dimensions. Experimental results on several diodes are presented, and their behavior explained in terms of the distributed resistance and an assumed lifetime law. A study of the mobility in the high injection intrinsic region was made, and an empirical formula for the variation with injection level established. It is shown that this formula lies between two proposed theories for mobility variation. Author (TAB)

N67-36922*# Raytheon Co., Waltham, Mass. Microwave and Power Tube Div.
THERMIONIC CATHODE EVALUATION STUDY Interim Report, 1 Jan.–30 Jun. 1967
F. T. Hill 17 Jul. 1967 53 p Prepared for JPL
(Contracts NAS7-100; JPLS-951810)
(NASA-CR-88499; PT-1490; IR-1) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A study is being made of the life capabilities of three different thermionic cathode types. This report presents the complete specifications of the cathodes, diode structure, cleaning and exhaust procedures, and preliminary electrical and life testing. A test diode has been designed and developed for testing electrical characteristics and life expectancy of the three cathode types. The pore-type dispenser cathode shows that it has the current loading capability of 0.2–1.6 amperes/cm^2 in the temperature ranges of 950°–1100°C. The barium strontium oxide cathode has the current loading capability of 0.075–0.60 amperes/cm^2 in the temperature range of 750–850°C. The coated powder cathode can be loaded to 0.138–1.10 amperes/cm^2 in the temperature range of 800°–900°C. A life test station has been designed and constructed to operate 48 test diodes with regulated cathode temperatures ranging from 750°–1100°C and with constant plate voltage on each socket ranging from 25–200 volts dc. Author

N67-36948*# Colorado State Univ., Fort Collins.
A DIRECT-CONVERSION DEVICE USING THERMALLY-ACCELERATED, CHARGED COLLOIDAL PARTICLES
Harry I. Leon and William R. Mickelsen *In its* Advanced Elec. Propulsion Res. Jul. 1967 15 p (See N67-36941 22-28)

Important parameters are described of each component of a direct conversion device using thermally-accelerated, charged colloidal particles. This direct conversion power generation system is an advanced concept especially suitable for use with charged-particle electric thrusters. This is a solid-state design and is capable of producing high-voltage, direct current power without any power conditioner. The proposed design could be used equally well for any space or ground powerplant where direct current, high- or low-voltage is required. R.U.

N67-36988* Unified Science Associates, Inc., Pasadena, Calif.
GASEOUS ELECTROLYTES FOR BATTERIES AND FUEL CELLS Quarterly Report, Feb. 1–Apr. 30, 1967
S. Naiditch 30 Apr. 1967 43 p
(Contract NAS7-437)
(NASA-CR-88608; QR-3) CSCL 10C

Effort was directed toward finding differences in the behavior of the electrode–electrolyte interface for liquid and gaseous electrolytes, with electrodeposition experiments being conducted to establish differences in the dynamic electrochemical properties. Experimental results indicate that major differences exist and that, as a by-product, it may be practical to produce single cyrstal whiskers out of the dense gaseous electrolyte. Two conductivity cells were designed and built to measure the conductivity of $AgNO_3$ in NH_3 as a function of temperature over the range between room temperature and temperatures well above the cirtical point of NH_3. The applicability of polarography to studying dense gaseous electrolytes is reviewed, and details are given on a polarographic cell designed to be used with these electrolytes. The experiment is expected to furnish information about species present, diffusion processes, and conditions at the electrode surface in a gaseous electrolyte. M.G.J.

N67-37011*# Gulton Industries, Inc., Metuchen, N. J. Alkaline Battery Div.
DEVELOPMENT OF PILE TYPE, HIGH DISCHARGE RATE NICKEL–CADMIUM SQUIB BATTERIES Quarterly Report, 5 Sep.–4 Dec. 1966
S. Charlip and T. Staub 4 Dec. 1966 25 p
(Contract NAS5-10160)
(NASA-CR-88607; QR-3) CSCL 10C

The work and results accomplished during the past quarter in a program directed toward the design and development of a pile type, nickel–cadmium, squib battery are summarized. Five-cell, pile type, nickel–cadmium batteries gave satisfactory performance when a sound seal was maintained between cells. Mechanical sealing with "O" rings and "quad" rings, followed by encapsulation with potting compounds, was unsatisfactory. Reliable seals were produced using adhesive bonding between the nickel substrate and uncured neoprene. The bond was formed during the vulcanization of the neoprene under heat and pressure. The proper cleaning and conditioning of the electrodes' nickel surfaces is an important factor in achieving reliable bonds. Author

N67-37064# Yardney Electric Corp., New York.
LONG LIFE STABLE ZINC ELECTRODES FOR ALKALINE SECONDARY BATTERY Quarterly Technical Progress Report, 28 Jan.–28 Mar. 1967
Jerome Goodkin Jun. 1967 40 p refs
(Contract DAAB07-67-C-0185)
(ECOM-0185-1; QTPR-1; AD-655285)

A program for the development of a stable long-life zinc electrode was initiated. A cell parameter study was undertaken to

investigate the relationship between binder, electrode area ratio, silver to zinc ratio, and electrode height-to-width ratio. A statistical design was developed and cells constructed based on this design. Techniques of preparing wet-proofed zinc oxide were studied. Two basic methods were evaluated and a successful batch technique was developed. Studies on methods of using the zinc electrode in a sealed cell system were initiated. The study was limited to an evaluation of third electrodes in silver-zinc oxide cells. Three types of platinum and carbon third electrodes are being studied. The data, to date, indicate that difficulties will be encountered when platinum electrodes are used. TAB

N67-37070* Naval Ammunition Depot, Crane, Ind.
LIFE CYCLE TESTS Monthly Progress Report, Period Ending 31 May 1967
1967 283 p
(NASA Order W-11252B)
(NASA-CR-88705) CSCL 10C

Cycling test data are tabulated on the nickel–cadmium, silver–cadmium, and silver–zinc cells. The data include ambient temperature, voltage limits, depth of discharge, orbit time, capacity, and failure analysis. N.E.N.

N67-37102*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SUMMARY OF TURBINE EROSION MEETING, DECEMBER 29–30, 1966
Lance G. Hays, ed. 15 Jun. 1967 211 p
(Contract NAS7-100)
(NASA-CR-88487; JPL-TM-33-354) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Presented is a summary of the proceedings of an informal meeting on turbine erosion. The purpose of the meeting was (1) to review two research programs being directed for the Office of Advanced Research and Technology, NASA; and (2) to provide an opportunity for researchers in this area to exchange their views and information. Cited are studies of limited impact erosion and metal losses in two-stage potassium turbines; analytical studies of turbine erosion phenomena; experiments on turbine erosion and internal flow; refractory metal potassium turbine experiments; mercury erosion and turbine experiments; turbine erosion during mercury Rankine turbo-alternator endurance tests; a model for multive drop impact erosion of brittle solids; the wet vapor turbine; experimental studies of internal flow in turbines; liquid and material removal phenomena; and erosion theory. S.C.W.

N67-37197*# Yardney Electric Corp., New York.
STUDY TO INVESTIGATE AND IMPROVE THE ZINC ELECTRODE FOR SPACECRAFT ELECTROCHEMICAL CELLS
James McBreen Jun. 1967 35 p refs
(Contract NAS5-10231)
(NASA-CR-88521; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 10C

The diffusivity of zincate has been investigated as a function of KOH concentration and temperature. A qualitative explanation is given for deviations from the Einstein–Stokes equation. Absorption isotherms of zincate in eight separators were measured. The distribution coefficient of zincate was measured and found to be less than one in all cases. Cellulosic separators and unplasticized polyvinylalcohol membranes show no variation in zincate absorption with stand temperature. The absorption of zincate ions in Borden Co. C-3 and 9107-5 increases with stand temperature. Additions of Emulphogene BC-610 do not affect the absorption of zincate in cellulosic separators. Author

N67-37220*# Brigham Young Univ., Provo, Utah. Dept. of Chemistry.
STUDIES OF REACTION GEOMETRY IN OXIDATION AND REDUCTION OF THE ALKALINE SILVER ELECTRODE Final Report
Eliot A. Butler and Angus U. Blackham 10 Apr. 1967 43 p refs
(Contract NAS7-100; JPL-951554)
(NASA-CR-88707) CSCL 10C

A double-Luggin capillary method has been used to measure potential variations in the vicinity of a working silver electrode. Current and potential distributions around several simple electrode configurations have been determined. These results can be extended to predict current density and potential variations around other electrode configurations. Equipotential maps are presented for several working electrodes. A comparison of experimental results from this study with a theoretical study on current distribution is made. A method for estimation of effective electrolytic surface area has been developed. A method for preparing a standard electrode surface which has area reproducible to ±3% is reported. Data are presented to show a reproducibility of ±10% in surface area estimations of sintered silver electrodes. Our observations indicate the presence of an organic residue on commerical sintered silver electrodes part of which is hydrocarbon in character and part of which is carbonaceous. Author

N67-37223*# TRW Systems Redondo Beach, Calif.
STUDY AND ANALYSIS OF SATELLITE POWER SYSTEMS CONFIGURATIONS FOR MAXIMUM UTILIZATION OF POWER Technical Report, 18 May 1965–18 Jul. 1966
Washington, NASA, Oct. 1967 291 p
(Contract NAS5-9178)
(NASA-CR-898; TRW-04898-6001-R000) CFSTI: HC $3.00/MF $0.65 CSCL 10B

Solar array power systems were analyzed and evaluated, and the use of radioisotope thermoelectric generators as the primary electric power source was investigated. An analytical method for evaluating the power systems was developed. The power systems studied were for the earth-synchronous communications satellite, sun-synchronous navigation satellite, and scientific satellite having an inclined elliptical orbit. The communications, data handling, stabilization and control, experiments, and electrical power subsystems were examined. Performance characteristics were analyzed in depth for each of the following equipment types: energy sources, energy source controls, energy storage, energy storage controls, and load power conditioning equipments. It is concluded that high efficiency is obtained by centralized equipment, low number of output voltages, high distribution voltages, and a central ac bus. It is further pointed out that the maximum efficiency solar array is also the minimum weight array, and that radioisotope thermoelectric generators will probably be used only for special purposes. N.E.N.

N67-37250# Eagle-Picher Co., Joplin, Mo.
DESIGN OF STANDARD LINE OF VENTED SILVER–ZINC BATTERIES Quarterly Report, 10 Jan.–9 Apr. 1967
B. R. Hawkins and E. S. Carr Ft. Monmouth, N. J., Army Electron. Command, Jul. 1967 21 p
(Contract DAAB07-67-C-0216)
(QR-1; ECOM-0216-1; AD-656623)

The purpose of the contract is to design and qualify a standard line of BB-462( )/U, BB-463( )/U, BB-464( )/U and BB-465( )/U vented silver-zinc batteries. A cell test series was initiated, primarily to obtain additional cycle data during the time required for molded cell case and cover tooling. Several cell designs are being evaluated, primarily in the BB-465( )/U configuration. In addition to preliminary manual cycles, test cells underwent in excess of sixty automatic cycles, with no failures. Design variables include type of separation, method of wrap, plate fabrication and electrolyte concentration. TAB

N67-37253*# Union Carbide Corp., Cleveland, Ohio. Fuel Cell Dept.

DEVELOPMENT OF FUEL CELL ELECTRODES Semiannual Report, 1 Jan.–30 Jun. 1967

R. L. Baum, M. B. Clark, and B. H. Eckstein 30 Jun. 1967 144 p refs

(Contract NAS3-9430)

(NASA-CR-72304) CSCL 10A

Thirty-six hydrogen–oxygen fuel cells were tested with circulating KOH electrolyte. The majority of these tests were at 200 ASF and 90°C, although limited tests were conducted at 100 ASF, 300 ASF, and on a simulated NASA duty cycle involving periodic power cycling. Testing at 200 ASF was conducted both at 15 psia and 30 psia. Typically increasing the pressure from 15 to 30 psia resulted in about a 40 mv increase in cell potential. Of the 15 small cells tested at 200 ASF and 15 psia, 10 had an initial potential of 0.90 volt at 200 ASF. From the same group 8 stacks had a potential decay rate of less than 20 mv in 500 hours. One-third of the cells met both milestones. Two stacks from this group operated for more than 2000 hours. Six small cells were tested at 200 ASF and 30 psia. Four all met the initial voltage milestone and two also met the voltage degradation milestone. Four flight size cells were tested; two at 15 psia and two at 30 psia. All four met the voltage decay milestone, and the two 30 psia tests also met the initial potential milestone. Excellent performance of those cells operating under the simulated duty cycle was observed. Author

N67-37302*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ANALYSIS OF CENTAUR PROPELLANT UTILIZATION DIFFERENCE BRIDGE

O. James Magrini Washington, NASA, Oct. 1967 44 p ref

(NASA-TM-X-1440) CFSTI: HC $3.00/MF $0.65 CSCL 21H

A propellant utilization (PU) system manages the outflow of propellants in order to reduce residuals (the masses of liquid oxygen and hydrogen remaining in the tanks at engine shutdown). The difference bridge in the Centaur PU system performs the function of comparing the masses of fuel and oxidizer so that the system can correct for a deviation from the desired mass ratio. An analysis was performed on the difference bridge to determine bridge sensitivity, factors that affect bridge balance, and effects of telemetry circuit malfunctions on the bridge. The results of the analysis show the following: (1) The output sensitivity of the bridge is as specified. (2) The bridge balance is not affected significantly by specified variation of parameters. (3) Telemetry circuit malfunctions, with the exception of loss of prime power, do not significantly affect the bridge balance. With the exception of the effect on the main bridge due to loss of 400-hertz power to the quantity-readout circuits, the design of the bridge is adequate. Author

N67-37361* Space Ordnance Systems, Inc. El Segundo, Calif.

DESIGN, DEVELOPMENT AND DELTA QUALIFICATION OF THE SINGLE BRIDGEWIRE APOLLO STANDARD INITIATOR Monthly Progress and Final Report, Oct.–Nov. 1966

Gerald L. Drinkard Nov. 1966 14 p

(Contract NAS9-5689)

(NASA-CR-65732; PR-6174) CSCL 19A

Data sheets are presented on the test firings of the igniter, nut cartridge, bolt cartridge, and end detonating cartridge. It is reported that the performance of the units using the single bridge wire Apollo standard initiator was comparable to performance of units that used the four-pin Apollo standard initiator. M.G.J.

N67-37387# Bendix Corp., Southfield, Mich. Research Labs. Div.

FLUID STATE AMPLIFIERS FOR CONTROL APPLICATIONS

L. B. Taplin and W. F. Datwyler [1965] 80 p refs Presented at AIAA Chicago Sect. Dinner Meeting, Chicago, 7 Dec. 1965

(RLDP-65-23)

An overview of fluid state technology and fluid amplifiers is presented, and some of the ways in which fluid interaction can be used to perform useful functions are explained. Typical elements, circuits, and systems are described in relation to control applications. Flow modulation mechanisms are considered under the basic categories of jet interaction, jet-to-surface interaction, and vortex flow. Signal amplification is detailed, and impedance matching criteria and circuit techniques are discussed. The basic fluid elements are reviewed and illustrated; and their uses in oscillators, pulse shaping networks, flip-flops, and binary counters are discussed. Vortex proportional amplifiers and circuits are described. M.W.R.

N67-37405*# Gulton Industries, Inc., Metuchen, N. J. Alkaline Battery Div.

CHARACTERIZATION OF RECOMBINATION AND CONTROL ELECTRODES FOR SPACECRAFT NICKEL-CADMIUM CELLS Quarterly Report, Dec. 9, 1966–Mar. 9, 1967

S. Lerner 9 Mar. 1967 48 p ref

(Contract NAS5-10241)

(NASA-CR-88609; QR-3) CSCL 10C

Cells containing active Adhydrodes and fuel cell scavenger electrodes have been investigated as to their cycling and gassing characteristics at various temperatures. It has been shown that cells containing a fuel cell scavenger electrode have superior low temperature cycling, as well as gassing, characteristics when compared to standard VO-12HSAD cells. Author

N67-37448 Royal Aircraft Establishment, Farnborough (England).

HARMONIC COMMUNICATION APPLIED TO AN EXPERIMENTAL STATIC INVERTER AND ITS APPLICATION TO BRUSHLESS D.C. MOTORS

D. E. Marshall Feb. 1967 36 p refs

(RAE-TR-67048)

A method of commutating the thyristors in a brushless d.c. motor was required which is simple and more reliable than existing methods. A method termed harmonic commutation is described which is closely analogous to interpole commutation in continuous current machines. A laboratory model of an invertor has been constructed to show the feasibility of the scheme. Harmonic commutation is suitable for constant speed motor application, i.e., induction motor drives, but its use in variable speed application would require unduly heavy commutating components. Author

N67-37470* Thermo Electron Engineering Corp., Waltham, Mass.

SIX-CONVERTER SOLAR THERMIONIC GENERATOR (JG-4) Quarterly Progress Report, 10 Jan.–30 Jun. 1967

T. Athanis and L. Lazaridis 30 Jun. 1967 77 p Prepared for JPL

(Contracts NAS7-100; JPL-951770)

(NASA-CR-88497; TE-4073-3-68) CSCL 10A

Work under this contract involves the design and fabrication of a Six-Converter Solar Thermionic Generator. Efforts during the reporting period were expended primarily in the reevaluation of the original design and the development of a new design which, along with its theoretical justification and operational characteristics is discussed in detail in Appendices of this report. Other efforts included the fabrication and processing of various parts required in the construction of the JG-4 and not affected by the new design. Author

N67-37504# Naval Air Development Center, Johnsville, Pa. Aero-Electronic Technology Dept.
VARIABLE PARAMETER POWER SOURCE Final Report
E. C. Lesoravage 15 Jun. 1967 26 p refs
(NADC-AE-6721; AD-655440)

A variable parameter power source was designed and fabricated to provide a 30-kva 3-phase source of power with controllable voltage modulation, frequency modulation and harmonic content for the purpose of simulating these power characteristics as described in MIL-STD-704. Author (TAB)

N67-37555*# Houston Research Inst., Inc., Tex.
CAUSES AND EXPLANATION OF "BREAKTHROUGH PHENOMENON" WHEN LEM COOLING SYSTEM SUBLIMATOR IS FED WITH CHLORINATED FEEDWATER
Frank L. Worley, W. I. Honeywell, and Allen H. Blair 30 Aug. 1967 24 p refs
(Contract NAS9-6695)
(NASA-CR-65735) CFSTI: HC $3.00/MF $0.65 CSCL 13A

The chemical, physical, and hydrodynamic behavior of the chlorine–water–nickel system was investigated to explain the unusual phenomenon associated with use of chlorine as a bactericide in the sublimator. The effects of using iodine as a bactericide were also considered. Findings indicate that the breakthrough phenomenon is a result of vapor pressure and freezing point depression caused by an accumulation of the salt $NiCl_2$. This salt is produced when chlorinated water is exposed to the highly divided nickel surface in the sublimator plate, particularly in the presence of nickel oxide. When iodine was used there was no reaction between the iodine and the nickel. It is concluded that the system should operate on iodated feed water in the same manner as with pure feed water. However, since the mechanism controlling the rate of removal of iodine is very dependent upon the physical configuration and operating conditions, it is recommended for safety reasons that empirical physical tests of the iodine system be carried out. E.C.

N67-37559*# Electric Storage Battery Co., Yardley, Pa. Carl F. Norberg Research Center.
HEAT STERILIZABLE, IMPACT RESISTANT CELL DEVELOPMENT Quarterly Report, Apr. 1–Jun. 30, 1967
G. W. Bodamer, ed. 1 Aug. 1967 65 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951296)
(NASA-CR-88816; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 10C

Sixteen cells, assembled with components suitable to resist heat sterilization effects, were sealed, sterilized, formed, satisfactorily cycled, and are now on stand or float. Gas generation studies in sealed cells were concerned with pack tightness, separator type, position of separator, type of additive, and the couple effect between zinc and its silver grid. Gas generation continues to be unpredictable. The study of sealed sterilized silver–cadmium cells on stand, cycle, or float was delayed by a leaking sterilization bomb. Work is again underway with emphasis on the performance of SWRI-GX separator. Highly reliable case-to-cover seals were obtained with PPO-531-801 using an epoxy adhesive. A crack free cover with silver terminals molded in was not achieved. Covers of PPO-541-801 containing molded-in silver terminals were crack free, but the epoxy case-to-cover seals were unsatisfactory. Shock testing of silver–zinc cells with plastic reinforced electrodes failed at the 10,000 g impact. Sheet metal reinforced electrodes are now being fabricated for shock testing. R.N.A.

N67-37778*# Atlas Chemical Industries, Inc., Valley Forge, Pa. Aerospace Components Div.
DESIGN AND FABRICATION OF FOUR PIN HIGH PRESSURE SQUIB Quarterly Report
Sep. 1967 40 p refs
(Contracts NAS7-100; JPL-951912)
(NASA-CR-88881) CFSTI: HC $3.00/MF $0.65 CSCL 19A

This report covers work in developing, providing design and production drawings for, and manufacturing an initial developmental production quantity of squibs to withstand the extremes of thermal shock and other rigid environmental requirements of deep space probe vehicles. The squib must be capable of withstanding heat sterilization of 293°F for 324 hours. It must be capable of functioning at any temperature from −200°F to +300°F, and must be suitable for exposures of up to one year at any temperature from −400°F to +250°F. In addition, the squib must withstand pressures of up to 30,000 psi without seal failure and must be capable of functioning normally after repeated discharges of 25 kv from a 500 picofarad capacitor. The squib will be a 1 amp, 1 watt no fire, dual circuit squib, whose output and initiation characteristics will be as uniform as is possible within the current limitations of the state-of-the-art. Author

N67-37879*# TRW Systems Group, Redondo Beach, Calif.
POWER SYSTEM CONFIGURATION STUDY AND RELIABILITY ANALYSIS Final Report
W. G. Binckley 18 Sep. 1967 267 p refs Prepared for JPL.
(Contracts NAS7-100; JPL-951574)
(NASA-CR-88479; TRW-07171-6001-R000) CFSTI: HC $3.00/MF $0.65 CSCL 10B

Analyses of photovoltaic electric power system configurations for interplanetary missions to Mercury, Venus, Mars and Jupiter are covered. Seven model missions and spacecraft configurations and representative power levels and required load power characteristics for each model are presented. Analyses of alternative methods of configuring electric power systems and of implementing the various system functions are discussed. Candidate power system configurations are defined and methods of improving power system reliability and the effects of these improvements on the weight and efficiency of each unit are described. A computer program developed in this program for assessing the reliability and weight of candidate systems and selecting optimum system configurations on the basis of maximum reliability and minimum weight is described. Preliminary definitions of optimum power system configurations for each model mission/spacecraft resulting from the use of this computer program are presented. Salient design considerations in implementing these systems are discussed and include electromagnetic compatibility, thermal interfaces, and command and telemetry provisions. Author

N67-37955# Babcock and Wilcox Co., Barberton, Ohio. Boiler Div.
SODIUM-HEATED STEAM GENERATOR DEVELOPMENT Quarterly Progress Report, Jan.–Mar. 1967
1 Jun. 1967 20 p
(Contract AT(11-1)-1280)
(BAW-1280-44) CFSTI: HC $3.00/MF $0.65

Engineering work on the Prototype Steam Generator is complete except for routine changes to detail drawings, final design of test instrumentation to be installed in the steam generator, and the operating instruments and test procedure. Fabrication of the Prototype Steam Generator has been held up by the inadvertent overheating of a superheater riser tube during working. As a result of this problem all tubes in the steam generator have been cleaned and re-examined using dye penetrant techniques. Any tubes that had dye penetrant indications were replaced. A total of four

confirmed overheated spots or questionable areas were found and all of these tubes have been replaced. Seventeen superheater downcomer tubes were removed from the superheater inlet tube sheet to check the tubes for overheating. The procedure for rewelding these tubes to the tube sheet resulted in poor fusion because of tube mis-alignment. A revised procedure is being developed. Mock-ups will be built to prove out the repair procedure before it is attempted on the actual steam generator. Author (NSA)

N67-37957# Babcock and Wilcox Co., Barberton, Ohio. Boiler Div.

SODIUM-HEATED STEAM GENERATOR DEVELOPMENT Quarterly Progress Report, Oct.–Dec. 1966

1 Feb. 1967 18 p

(Contract AT(11-1)-1280)

(BAW-1280-43) CFSTI: HC $3.00/MF $0.65

Detail design of the Prototype Steam Generator is approximately 99% complete and fabrication approximately 85% complete when a fabricating problem occurred. A small spot was noticed on one of the superheater riser tubes being prepared for welding to the superheater outlet tubesheet. This spot proved to be an overheated area from improper control of a hot forming operation. A sample was removed and metallographic examination disclosed oxide filled cracks or penetrations to a depth of approximately one-third the tube wall thickness. All work on the pressure parts of the steam generator was held up until it could be determined how many additional tubes might have been overheated. A procedure was worked out for cleaning and inspecting each tube in the steam generator throughout the entire length where any hot work had been performed. This inspection is now in progress. Author (NSA)

N67-37981*# Allis-Chalmers Mfg. Co., Milwaukee, Wis. Research Div.

FUEL CELL RELIABILITY ASSESSMENT Quarterly Progress Report, Apr. 8–Jul. 8, 1967

R. P. Bruno 25 Aug. 1967 25 p

(Contract NAS8-2696)

(NASA-CR-88637; QPR-2001) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Continuing thermal cycle and life tests and analyses on fuel cell stacks are reported. Stack 137 was found to have a greatly improved degradation rate over that of Stack 136. The effectiveness of flow restrictors in the oxygen inlet ports of the fuel cell plates was investigated and an expression was developed which indicates that the flowrate through the plate is inversely proportional to its pressure drop. An analysis of degradation rates of two stack groups shows that the vacuum electrolyte loading process increases stability and uniformity of section voltages, reduces degradation rates, and eliminates crossleaks within the cells. The limitations of high power spikes loads determined by cooling capabilities are described. It was determined that cannister gas mixtures have a minimum auto-ignition of 540°C, while the fuel stack operates at about 100°C. N.E.N.

N67-37994*# Gulton Industries, Inc., Metuchen, N. J.

INVESTIGATION OF STERILIZATION OF SECONDARY BATTERIES Final Report

John Liska Aug. 1967 40 p

(Contract NAS1-5708)

(NASA-CR-66458) CSCL 10C

A study was conducted to develop a nickel–cadmium cell that can be thermally sterilized at 145°C, and yield a power density and cycle life approaching that of present state-of-the-art nickel–cadmium cells. A number of existing separator systems are evaluated; the more sterilization resistant types being incorporated into cells. Two asbestos and one polypropylene separator systems appear the most promising. Tests indicate that the nickel plate contributes to the capacity loss while the negative plate limits the overcharge capability following thermal sterilization. X-ray spectrographs of the nickel-plate before and after sterilization are shown. Author

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N67-36683# Naval Air Development Center, Johnsville, Pa. Aerospace Medical Research Dept.

CALCULATION OF TIME-TEMPERATURE HISTORIES AND PREDICTION OF INJURY TO SKIN EXPOSED TO THERMAL RADIATION

John A. Weaver 14 Jun. 1967 38 p refs

(NADC-MR-6623; AD-655438)

A general description is given of a digital computer program used in connection with the study of injury of skin exposed to thermal energy. All of the information necessary for a detailed understanding of the program is included; however, the material is presented in a manner such that a novice in the field of computer science may make use of the program if he so desires. For this reason emphasis is placed on the operating instructions for the program. A short discussion of the pertinent theory and equations as they apply to the human skin is included at the beginning of this report. Author (TAB)

N67-36709# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

PHYSIOLOGICAL PRINCIPLES OF A SOJOURN OF A HUMAN IN CONDITIONS OF RAISED PRESSURE OF THE GASEOUS MEDIUM

G. L. Zal'tsman 17 Apr. 1967 190 p refs Transl. into ENGLISH of the book "Fiziologicheskiye Osnovy Prebyvaniya Cheloveka V Uslouiyakh Povyshennogo Davleniya Gazovoy Sredy" Leningrad, Medgiz, p 1–166

(FTD-MT-65-245; TT-67-62351; AD-655380)

The monograph describes the manifold processes arising in the organism with an increase in the pressure of oxygen, air, and artificial gas mixtures. Various types of physiological affect of raised pressures are analyzed in the light of contemporary concepts of the stimulus, the process of irritation, and physiological and pathological response reactions. For the study of the state a human in the conditions of the applied pressures of the gaseous environment there are developed methodical procedures which allow characterization of nervous processes from elementary unconditioned responses to complicated cortical reactions. As a result of the investigations three types of suppression of the work of the brain which arise under the action of raised pressures are singled out. TAB

N67-36721* Southern Illinois Univ., Carbondale. Physiology Dept.
ABSORPTION KINETICS OF GLYCINE IN MACRACANTHORHYNCHUS HIRUDINACEUS (ACANTHOCEPHALA)
Arthur Andre Swanson, III (M.S. Thesis) Aug. 1966 43 p refs
(Grant NGR-14-008-003)
(NASA-CR-88384) CSCL 06M

An investigation was made of the kinetics involved in the absorption of glycine in *Macracanthorhynchus hirudinaceus* over an extended period, including the effect of glycine concentration of absorption rate, the effect of other amino acids and cyanide on glycine absorption, pH effect on glycine absorption, and glycine metabolism and distribution. Results show that diffusion seems to be the dominant mechanism of glycine absorption in *M. hirudinaceus*. Glycine distribution is uniform over the entire body and its metabolism is mainly in protein synthesis. The pH curve of glycine absorption is between pH 7.0 and 9.0. This is an indication of the membrane properties of the organism which accepts the glycine more readily in its neutral form. R.N.A.

N67-36735# Authority Health and Safety Branch, United Kingdom Atomic Energy Authority, London (England).
THE APPLICATION AND INTERPRETATION OF ICRP RECOMMENDATIONS IN THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY (JUNE 1967)
H. J. Dunster Harwell, Engl., Jun. 1967 25 p refs
(AHSB/RP/-R-78) CFSTI: HC $3.00/MF $0.65

Numerical values of dose limits are summarized, and applications of the recommended values are described. Maximum permissible doses and derived working limits for exposure of workers and the public are given and the data are tabulated. Predictable working conditions as well as emergency and accidental exposures are discussed. N.E.N.

N67-36756* Systems Technology, Inc., Hawthorne, Calif.
A NEUROMUSCULAR ACTUATION SYSTEM MODEL
D. T. McRuer, R. E. Magdaleno, and G. P. Moore 1967 38 p refs
(Contracts NAS2-2824; AF 33(657)-10835)
(NASA-CR-73128) CSCL 06P

Recently both high quality physiological data and human operator describing function data of low variability and large dynamic range have become available. These data lead to control engineering descriptions for neuromuscular actuation systems which are compatible with the available data and which provide insight into the overall human control structure (e.g., the types of feedback systems used for various inputs). In this paper, some of these physiological and human operator data are briefly reviewed, and a simple neuromuscular actuation system model is presented. The pertinent human operator describing function data include the covariation of high and low frequency phase data and the describing function variation of high frequency phase with tension. The simplest neuromuscular model suggested by and compatible with these data is one in which muscle spindles provide both a feedback function, an operating point or bias adjustment, and at least one command path. Author

N67-36762 Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Bad Godesberg (West Germany). Institut fuer Flugmedizin.
THE APPLICATION OF THE OXYGEN RESPIRATION DURING THE DECOMPRESSION OF CAISSON WORKERS AT THE CONSTRUCTION PLACE ROHRTUNNEL BRUNSBUETTELKOOG [DIE ANWENDUNG DER SAUERSTOFFATMUNG BEI DER AUSSCHLEUSUNG VON DRUCKLUFTARBEITERN AUF DER BAUSTELLE ROHRTUNNEL BRUNSBUETTELKOOG]
Otto Wuensche, Hans Dietrich Fust, and Gerhard Pressel Jul. 1967 35 p refs In GERMAN; ENGLISH summary
(DVL-663; DLR-FB-67-47)

The effectiveness of oxygen decompression procedures was studied, improved, and statistically verified. Oxygen respiration equipment is described and illustrated. A comparison is made of the rate of incidence of decompression sickness during decompression with compressed air and oxygen respiration. Workers were observed and examined during a four-month period while on six and eight-hour shifts at a pressure of 2.2 kp/cm^2. Decompression by oxygen respiration resulted in a sharp decrease in the rate of sickness. Results are also presented of examinations which determined the number of leukocytes and eosinophile blood cells. Transl. by K.W.

N67-36769* Arkansas Univ., Fayetteville.
[THE ROLE OF NUCLEOTIDE METABOLISM IN THE REPAIR OF RADIATION INJURY] Annual Report
Glenn V. Dalrymple [1967] 36 p refs
(Grant NGR-04-001-014)
(NASA-CR-88379) CSCL 06R

A research program summary results are presented on the effect of radiation on L cells during the immediate post-irradiation period. Also described is the effect of 2,4-dinitrophenol on the radiation sensitivity of L cells. The non-linear method for the fitting of cell survival curves is investigated. Autoradiographic and survival studies with synchronous L cells are reported. R.U.

N67-36818# Naval Air Development Center, Johnsville, Pa. Aerospace Medical Research Dept.
HUMAN ACCELERATION EXPERIENCE AT THE AEROSPACE MEDICAL RESEARCH DEPARTMENT, U.S. NAVAL AIR DEVELOPMENT CENTER—JOHNSVILLE: 1 JANUARY 1961–30 DECEMBER 1965
Elihu York, R. J. Oleynik, and R. M. Patton 31 May 1967 18 p refs
(NADC-MR-6711; Rept.-12; AD-655436)

A five year retrospective survey was undertaken in order to learn the consequences of acceleration exposure on human subjects. Utilizing a punched-card data system, 5071 human subject runs involving 380 individuals were analyzed. Symptomatology occurred in 75% of Gz runs and 52% of Gx runs. During 2380 +Gz runs greyout was noted 351 times and blackout 167 times; during 2557 +Gx runs, chest pain occurred 104 times, motion sickness 97 times, cardiac arrythmia and dyspnea 29 times each. Miscellaneous complaints during acceleration included myalgia, headache and abdominal pain. No disabling sequelae were noted in any subject. A medical monitoring system comprised of voice communication, television observation, and electrocardiographic recording from the subject proved to be a safe system for recording minimal responses. As man is exposed to more hazardous environments of high-performance jet aircraft or space capsules, more detailed information involving further experimentation with the human centrifuge may be required, employing complex monitoring systems, in order to gain adequate knowledge of mans tolerance to acceleration, an important variable affecting manned flight. Author (TAB)

N67-36819# Army Medical Research Lab., Fort Knox, Ky.
SUBJECTIVE ESTIMATION OF EFFORT, RESERVE, AND ISCHEMIC PAIN Interim Report
Lee S. Caldwell and Richard P. Smith (Louisville Univ.) 12 May 1967 16 p refs
(Rept.-730; AD-655568)

Two studies were conducted to compare: (1) ratings of pain and effort induced by a muscle contraction maintained to the limit of endurance; and (2) estimates of effort and reserve using five- and ten-point scales both covering the same range of sensations. No overall differences were found between the ratings of pain and effort, though there was statistical evidence that the two scales diverged as the contraction time increased, or as the sensations

increased in intensity. The rate of growth of the sensations of pain and effort were influenced by the strength of the muscle contraction. The ratings of effort and reserve were highly correlated, and significantly different only for the five-point scale. There was no indication of a divergence of the ratings of effort and reserve with contraction time. The results of both studies indicate that Ss are capable of reliably scaling the subjective experiences produced by strenuous physical exertions. Author (TAB)

N67-36830# Army Natick Labs., Mass. Food Lab.
HYGROSCOPIC EQUILIBRIUM AND TEXTURE OF FREEZE-DRIED FOODS
John G. Kapsalis Jun. 1967 185 p refs
(TR-67-87-FL; AD-655488)

Improved methodology for the objective evaluation of food texture was applied to the measurement of the textural parameters of special freeze-dried foods which were storage-equilibrated under different relative humidity conditions. The foods included pre-cooked freeze-dried beef, laminated freeze-dried products in the form of bite-size sandwiches, and compressed freeze-dried cubes, all of which were designed for consumption without prior rehydration. The results showed that increasing relative humidity from zero to 66% caused an increase in hardness and cohesiveness, and, in certain foods, a decrease in brittleness (crushability index). This was more pronounced at equilibrium points above the B.E.T. value for a monomolecular layer of water. Plots of physico-chemical parameters of water vapor sorption versus rheological properties at different points of the moisture sorption isotherm were examined. The selection of certain target relative humidity values to minimize undesirable changes upon storage, and promising avenues for continued work on the textural quality and acceptability of special freeze-dried foods are discussed. Author (TAB)

N67-36893# Cajal Inst., Madrid (Spain).
NEURONAL PATTERNS ASSOCIATED WITH AFFECTIVE RESPONSES Final Scientific Report, 1 Feb. 1966–31 Jan. 1967
Antonio Fernandez De Molina 15 Feb. 1967 15 p refs
(Contract AF 61(052)-939)
(AFOSR-67-1604; AD-655795)

The properties of the fibres of the stria terminalis have been analyzed on the basis of threshold, conduction velocity and absolute refractory period in anesthetized cats in which the stria terminalis was widely exposed. Both, fast and slow fibres, relay in the bed nucleus of the stria. Spontaneous unitary activity in the anterior and ventrome - dial hypothalamus had a predominant frequency of 6/sec., being both facilitated and inhibited by amygdaloid stimulation. Correlation of neuronal firing patterns, amygdaloid efferent pathways and location of units has been analized. Author (TAB)

N67-36964* Southern Illinois Univ., Carbondale.
[EFFECT OF CHRONIC RESTRAINT ON ABSORPTION FROM THE GASTROINTESTINAL TRACT]
George H. Gass [1960] 27 p refs
(Grant NGR-14-008-003)
(NASA-CR-88512) CSCL 06C

A comparative analysis is presented on restrained and unrestrained (control group) male rats to determine the influence of absorption from the gastrointestinal tract. Food and water were allowed *ad libitum*; however, food was removed 24 hours prior to *in vivo* experiments to reduce the contents of the gastrointestinal tract. It was found that more deaths occurred in restrained than control animals, and no deaths occurred after the 13th week. Restrained animals do not grow as fast nor grow as large as unrestrained animals, but do continue to grow. No difference was observed between groups in either adrenal or thymus gland weights. R.U.

N67-36996# School of Aerospace Medicine, Brooks AFB, Tex.
THE EFFECT OF NITROGEN DIOXIDE–NITROGEN TETROXIDE ON OXYHEMOGLOBIN DISSOCIATION Final Report, Mar.–Sep. 1966
William H. Pryor, Harold L. Bitter, and Raymond J. Bertler Apr. 1967 13 p refs
(SAM-TR-67-33; AD-655595)

Twelve dogs were exposed to 180 p.p.m. nitrogen dioxide-nitrogen tetroxide until death occurred. Oxyhemoglobin dissociation curves were plotted on each subject before and after exposure. Percent saturation was thus used as a measure of ability to transport oxygen. It was determined that NO2/N2O4 exposure reduced the oxygen-carrying capacity of hemoglobin by 10% to 15% throughout the physiologic range. There was a rise in methemoglobin concentration that was not sufficient to account for the shift in the oxyhemoglobin dissociation curve, despite its being statistically significant. Although chronic exposures were not a part of this study, it is suggested that a similar reduction in hemoglobin function could result from long-term inhalation of air polluted with these gases. Author (TAB)

N67-37000*# Technology Inc., San Antonio, Tex. Life Sciences Div.
INVESTIGATION OF STRENGTH OF ISOLATED VERTEBRAE, PHASE IV Final Technical Report, 29 Oct. 1965–28 Oct. 1966
Jeremy F. Crocker and Lawrence S. Higgins 28 Oct. 1966 30 p refs
(Contract NASw-1313)
(NASA-CR-88610; TI-1313-66-4) CFSTI: HC $3.00/MF $0.65 CSCL 06P

This report summarizes research conducted on isolated human vertebrae during the year 1965–1966. The dynamic strength of specimens from portions of two human spines was determined. Relative dynamic strengths of centra versus intervertebral discs were measured. The results are presented as a series of graphs which compare experimental values with those found in the literature. Author

N67-37005# Naval School of Aviation Medicine, Pensacola, Fla.
AIRSICKNESS AND ANXIETY
Gary J. Tucker and Roger F. Reinhardt Dec. 1966 24 p refs
(NAMI-988; AD-655633)

The report explores the relation of airsickness experienced early in flight training to anxiety, attrition rates, and the instructor-student interaction. During a two-month period, all students undergoing primary flight instruction (N = 141) filled out a detailed questionnaire immediately after their fifth flight. Seventy-two of these students, randomly selected, were studied more intensively, in that: (1) their flight instructor also filled out a questionnaire after the fifth flight, and (2) this group was surveyed again at the completion of primary training. The airsick group differed significantly from the nonairsick in the following subjective areas: (1) more nervousness, (2) more autonomic symptoms, (3) lower motivation, and (4) finding instructors less likable. The airsick group tended to have a higher attrition rate, and still experienced more anxiety at the completion of primary training. The data represent the first large scale correlation of airsickness in early flight training with subjective anxiety, and, as such, present many theoretical and practical implications. Author (TAB)

N67-37113*# Mayo Clinic, Rochester, Minn.
STUDIES OF THE EFFECTS OF GRAVITATIONAL AND INERTIAL FORCES ON CARDIOVASCULAR AND RESPIRATORY DYNAMICS Semiannual Status Report

Earl H. Wood 10 Aug. 1967 19 p refs
(Grant NsG-327)
(NASA-CR-88529) CFSTI: HC $3.00/MF $0.65 CSCL 06C

Progress is reported on projects dealing with the effects of gravitational and inertial forces on intrathoracic pressure relationships in chimpanzees, regional effects of gravitational and inertial forces on pulmonary arterial-venous shunting, effects of gravitational and inertial forces on regional distribution of pulmonary blood flow, regional effects of the head-up and head-down positions on intrapleural and circulatory pressures and pulmonary blood flow, the nature of the pleural space, the development of biplane roentgen videodensitometry, the development of time shared on-line and real time electronic data processing and computer techniques, techniques for beat-to-beat determination of end-diastolic left ventricular pressures in dogs during different circulatory states, mitral valve function studies using roentgen videodensitometry, effects of selective acute sympathetic and/or parasympathetic cardiac denervation on left ventricular function, the determination of circulating total blood volume from indicator dilution curves, and a closed loop search technique for finding the optimum atrial–ventricular stimulus interval under different hemodynamic conditions. R.N.A.

N67-37214 Medical Biological Lab. RVO-TNO, Rijswijk (Netherlands).
REVIEW OF MEDICAL PROBLEMS ENCOUNTERED IN DEEP SEA DIVING [OVERZICHT VAN DE MEDISCHE PROBLEMEN, DIE ZICH VOORDOEN BIJ HET DUIKEN OP GROTE DIEPTE]
E. Meeter Jun. 1967 23 p refs In DUTCH; ENGLISH summary
(MBL-1967-6; TDCK-48781)

The dangers during a prolonged stay at great depth, such as oxygen intoxication, inert gas narcosis, and carbon dioxide intoxication, are reviewed. Pathological phenomena seen after return to the normal environment are discussed. Attention is drawn to the differences in clinical signs which may occur, their patho-physiological background, and the consequences for therapy. Author

N67-37246# Tokyo Univ. (Japan). School of Medicine.
EFFECT OF HIGH ALTITUDE TO HEMATOPOIETIC PROCESS
Kazuo Asahina San Francisco, Army Res. and Develop. Group (Far East), May 1967 41 p
(Contract DA-92-557-FEC-37964)
(J-234-4; FR-2; AD-656529)

Changes in stroke volume of the right and left heart were studied in relation to tolerance to altitude. It was concluded that the pulmonary circulation might be regarded as a limiting factor of importance for performance at altitude. Chronic experiments on rabbits with chronic implanted heart electrodes were performed with partial success. The animals can be kept alive about one month after the operation. The results of these chronic experiments showed that the contractile capacity of the right heart is strengthened, increasing the right heart stroke volume within one week period of training-exposure to hypoxic condition. This fact supports the view that the improvement of the right heart capacity might be involved in the establishment of acclimatization to altitude. Changes in ascorbic acid in different organs at altitude are being studied in order to elucidate the role of this substance in acclimatization or tolerance to altitude. The results obtained so far show that the well acclimatized or tolerant animals have a larger capacity for utilizing ascorbic acid at altitude than do unacclimatized or less tolerant animals. This suggests that the administration of large amount of ascorbic acid may improve the tolerance to hypoxia. Author (TAB)

N67-37251# Rock Island Arsenal Lab., Ill. Research and Engineering Div.
MICROBIAL-METAL CORROSION—LITERATURE REPORT
Van Y. S. Hong Feb. 1967 33 p refs
(RIA-67-534; AD-655274)

The importance of microorganisms in the corrosion process was illustrated as related to their broad distribution in nature and their longevity of existence on earth. A limited literature survey was made in the five areas of Microbial Corrosion. These areas are: historical background, mechanisms of microbial corrosion, microorganisms and the metals and alloys they attack, preventive measures to counteract this corrosion, and examples of microbial corrosion in military equipment. A brief discussion of each area was made, and also a future research program was suggested in resolving some of the problems found in these areas. TAB

N67-37271# Naval Training Device Center, Orlando, Fla.
VIGILANCE PERFORMANCE AND PHYSIOLOGICAL RESPONSES UNDER FIXED AND VARIABLE SIGNAL SCHEDULES
John L. Andreassi, Salvatore C. Rapisardi, and Patricia M. Whalen May 1967 45 p refs
(NAVTRADEVCEN-IH-71; AD-655619)

The investigation was designed to: (1) determine the effects of signal patterning upon physiological responses and RT to the signals; and (2) provide some information with respect to the roles of expectancy and arousal in monitoring performance. Monitoring performance and physiological responses with variable interval (VI) and fixed interval (FI) signal patterns were studied in four Ss over an average of 10 days each. The Ss were required to expend some effort in order to obtain the critical signals. Reaction time (RT) was used as the performance measure while heart rate (HR), palmar skin conductance (PSC) and galvanic skin responses (GSRs) were the physiological measures. The RTs were significantly faster under the FI schedule than with VI. The PSC and GSR measures were significantly higher under FI than with VI, while HR was significantly greater with VI as compared to FI. Cumulative records showed typical response patterning to FI and VI schedules for three or four Ss. On the basis of these results it was suggested that: (1) faster RTs under the FI schedule reflect greater learning of the signal pattern under the FI schedule and perhaps the existence of an internal timing mechanism; (2) signal patterning does have an effect on physiological response and RT; (3) the difference between conductance phenomena and heart responses to the two signal patterns may be due to differential responsivity of the autonomic nervous system; (4) monitoring performance contains elements of both expectancy and arousal. Author (TAB)

N67-37353*# Scientific Translation Service, La Canada, Calif.
THE EFFECT OF VIBRATION AND NOISE ON THE MENTAL FACULTY OF MAN UNDER TIME STRESS [VLIYANIYE VIBRATSIY I SHUMA NA UMSTVEMUYU RABOTOSPOSOBNOST' CHELOVEKA V USLOVIYAKH DEFITSITA VREMENI]
K. K. Ioseliani Washington, NASA, Jul. 1967 6 p refs Transl. into ENGLISH from Kosmich. Biol. i Med. (USSR), v. 1, no. 2, 1967 p 79–82
(Contract NASw-1496)
(NASA-TT-F-11142) CFSTI: HC $3.00/MF $0.65 CSCL 05F

Sixty examinees in the age group of 25 to 45 years were studied. Prior to, during, and upon termination of vibration treatments, the examinees performed addition and substraction operations on numbers presented at varying speeds. Investigations demonstrated that the influence of total vertical vibrations, at a frequency of 70 cycles per second and an amplitude of 0.4 mm, reduces by as much as 1.5 to 2 times the qualitative accomplishment of the experimental task. The effect of noise at 90

decibels normally cuts the qualitative accomplishment of the task in half. The greater the time stress, the greater is the reduction of mental efficiency. Author

N67-37413 Institute for Perception RVO-TNO, Soesterberg (Netherlands).
EFFECTS OF HIGH-INTENSITY NOISE LEVELS ON THE HUMAN BODY [DE INVLOED VAN HOGE LAWAAINIVEAUS OP HET MENSELIJK LICHAAM]
L. C. W. Pols Mar. 1967 25 p refs In DUTCH; ENGLISH summary
(A66/KLu/039; IZF-1967-13; TDCK-48670)

A discussion is given, based on a number of publications, on the nonauditory influence of high-intensity noise levels on humans. The influence of low frequency mechanical vibrations is included in this study. Suggestions are made for maximum tolerable levels so far as the present data permit. Author

N67-37428*# National Aeronautics and Space Administration, Washington, D. C.
NYCTOMETRIC STUDIES AND THE EFFECT OF VESTIBULAR EXCITATION ON THE DARK ADAPTATION [NIKTOMETRIYA PRI IZUCHENII VLIYANIYA VESTIBULYARNOGO RAZDRAZHENIYA NA TEMNOVUYU ADAPTATSIYU]
T. A. Petrova, M. P. Kuzmin, I. Ya. Yakovleva, and V. P. Baranova Aug. 1967 7 p refs Transl. into ENGLISH from Kosmicheskaya Biol. i Meditsina (USSR), v. 1, no. 2, 1967 p 82–86
(NASA-TT-F-11143) CSCL 06P

The dark adaptation of the eye before and after excitation of the vestibular analyzer was studied on 50 healthy test subjects by the nyctometric method (the apparatus was calibrated for 100 people). The test OR_{10} was used as a vestibular stimulus. Changes in the rate of the dark adaptation were established with respect to the vestibular tolerance; high tolerance accelerated dark adaptation and low tolerance decelerated it. The possibility of specific interaction of the vestibular and optic analyzers was shown. Author

N67-37450*# Southwest Research Inst., San Antonio, Tex.
SOUTHWEST RESEARCH INSTITUTE ASSISTANCE TO NASA IN BIOMEDICAL AREAS OF THE TECHNOLOGY UTILIZATION PROGRAM Quarterly Progress Report, 1 Jun.–31 Aug. 1967
Ray W. Ware and Louis S. Berger 19 Sep. 1967 105 p refs
(Contract NASr-94; SwRI Proj. 14-1963)
(NASA-CR-88469; QPR-4) CSCL 06B

Methods are being developed to effectively transfer the maximum amount of applicable aerospace technology to the fields of medicine and biology. Information pertaining to each biomedical problem submitted is organized and maintained in the form of a case history. This report contains a list of submitted biomedical problems, summaries of individual problem case histories, a few problem abstracts accepted, a tabulation of documents furnished to problem originators, and a listing of problems with technology transfers accomplished, transfers in progress, and applicable technology identified. R.N.A.

N67-37462# RAND Corp., Santa Monica, Calif.
A MATHEMATICAL MODEL FOR POST-IRRADIATION HEMATOPOIETIC RECOVERY
J. P. Okunewick and A. L. Kretchmar (Tenn. Univ., Knoxville) Jul. 1967 40 p refs Prepared jointly with Oak Ridge Inst. of Nucl. Studies
(Contracts F44620-67-C-0045; AT(40-1)-GEN-33; Proj. RAND)
(RM-5272-PR; AD-655345)

A mathematical model is presented of the recovery after irradiation of the system producing blood cells in the body. The model is based on the hypothesis that hematopoietic stem cells, which are unable to reproduce as stem cells following irradiation, may still retain an ability to differentiate. The model demonstrates both an abortive recovery rise and a true recovery rise following irradiation. As a first approximation, the model shows no irreconcilable differences from experimental data and generally represents the phenomena observed in the recovery of erythropoiesis following acute irradiation. In addition, certain postulates basic to blood-cell development are derived. Author (TAB)

N67-37476*# Scientific Translation Service, La Canada, Calif.
THE EFFECTS OF LOW SALT CONCENTRATION UPON MARINE ORGANISMS [UBER DIE EINWIRKUNG NIEDERER SALZKONZENTRATIONEN AUF MARINE ORGANISMEN]
Carl Schlieper Washington, NASA, Sep. 1967 34 p refs Transl. into ENGLISH from Z. Vergleich. Physiol. (Berlin), v. 9, 1929 p 478–514
(Contract NASw-1496)
(NASA-TT-F-11226) CSCL 06C

Effects of salt concentration on nereis diversicolor, carcinus maenus, and mytilus edulis were investigated. Body surface permeability of marine animals is discussed. Author

N67-37493* Schwarz Bioresearch, Inc., Orangeburg, N. Y.
SUPERIOR DIET FOR MAN IN SPACE Annual Report, Oct. 1963–Oct. 1964
Norman A. Rosenthal Oct. 1964 128 p refs
(Contract NASw-517)
(NASA-CR-88617) CSCL 06H

Liquid diets were examined biologically from the standpoint of their ability to provide both the nutritional imperatives as well as nutritional electives in terms of their respective individual components. Evaluations of the role of concentration of various diet constituents, with particular regard to water content and amino acid pattern, were also made. Explorations of the factors contributing to the nutritional adequacy and diet stability of liquid diets were undertaken as well. Author

N67-37509*# Pennsylvania State Univ., University Park. Physiology Labs.
VASCULAR RESPONSES AND WOUND REPAIR IN MICE EXPOSED TO MODERATE AND SEVERE HYPOXIA
Diana R. Godish and Adam Anthony Sep. 1967 75 p refs
(Grants NGR-39-009-015(2); PHS GM-05112)
(NASA-CR-88517) CFSTI: HC $3.00/MF $0.65 CSCL 06C

Adult male A/HeJ mice were exposed to moderate (380 mm Hg) or severe (320 mm Hg) hypoxia for 7 to 40 days. The extent of peripheral angiogenesis was determined from weekly stereoscopic drawings of ear vasculatures in hypoxic and control mice; vascular proliferation was also microscopically observed in visceral tissues. Healing of peripheral wounds (ear puncture) was expressed as percentage of puncture filled with granulation tissue; internal body wound healing was studied histologically and histochemically. Supplemental information on vascular changes and wound repair was obtained from microscopic analysis of 6–8 μ sections. Data on hematocrit and body and organ weight changes were also recorded. A total of 234 animals was used. It was concluded that hypoxia exposure triggers a shift in blood distribution such that internal body tissues receive more blood while peripheral regions are supplied with only minimal amounts; another important effect of hypoxia is the stimulation of angiogenesis, first in the visceral tissues and later in peripheral regions. Author

N67-37557# RAND Corp., Santa Monica, Calif.
A BIBLIOGRAPHY ON NERVE CONDUCTION AND NERVE IMPULSES
Elizabeth McKeldin, Lois Newman, and Judith Wallach Jul. 1967 31 p refs *Its* Lit. Search No. 127
(P-3613; AD-654637)

The bibliography is concerned with the behavior of networks of nerve cells. Emphasis is placed on waves of nerve impulses passing through masses of nerve tissue, excluding brain waves (EEG). The bibliography does not include items dealing with automata or bionic devices; it does include items on the theory and simulations that apply very closely to the behavior of real (i.e., living) nervous tissue and networks. Author (TAB)

N67-37558# General Dynamics/Electronics, Rochester, N. Y.
COMMUNICATION AND INFORMATION THEORY ASPECTS OF THE NERVOUS SYSTEM Final Report, 1 Oct. 1964–30 Sep. 1966
Eugene Agalides Mar. 1967 86 p refs
(Contract AF 49(638)-1470)
(AFOSR-67-1522; AD-654629)

Transmission of information in living organisms is conveyed through the nervous system. It was proved that this information is transmitted in coded form; either as a unichannel–multicoding or a multichannel–multicoding system, skin sensory receptors, such as the Pacinian corpuscle and the Lorenzini ampulla, were used in the experiments. It was found that different types of stimuli would elicit different types of coded signals. Acoustic stimuli reaching a high amplitude level were found to stimulate not only the organism's auditory system but also its skin sensory system thereby reinforcing the general stimulation of the nervous system. Furthermore, it was found that if these high amplitude stimuli are extended over a long period of time—days, weeks, or months, depending on the stimulus—then such high amplitude stimuli become obnoxious to the organism, affecting different organs and impairing their proper functioning. Author (TAB)

N67-37591*# Miami Valley Hospital, Dayton, Ohio.
THE BIOCHEMICAL, PHYSIOLOGICAL, AND METABOLIC EVALUATION OF HUMAN SUBJECTS IN A LIFE SUPPORT SYSTEMS EVALUATOR AND ON A DIET OF PRECOOKED FREEZE DEHYDRATED FOODS Final Report, 12 Oct.–24 Nov. 1964
Bernard J. Katchman, George M. Homer, James P. F. Murphy, and Dorathea P. Dunco Wright-Patterson AFB, Ohio, AMRL, Jul. 1967 55 p refs
(NASA Order R-86; Contract AF 33(657)-11716)
(NASA-CR-88635; AMRL-TR-67-12) CFSTI: HC $3.00/MF $0.65 CSCL 06S

A 6-week study was conducted for the purpose of evaluating the water, caloric, and protein requirements of individuals undergoing stresses imposed by simulated aerospace conditions. The subjects were confined in a controlled activity facility for 2 weeks and in the Life Support Systems Evaluator for 4 weeks during which time they wore an unpressurized MA-10 pressure suit 8 hours each day for 14 consecutive days. A 3-day cycle diet of precooked freeze dehydrated foods was served at room temperature and was comprised of about 105 g of protein, 328 g of carbohydrate, 89 g of fat, and 2600 kcal per day. The daily requirement of water was 2200 ml per man day of which 700 ml were consumed ad libitum. The diet was highly acceptable and efficiently utilized. Only minimal body weight changes were observed. The nutrient intake of the diet was adequate in that a 70 kg man was maintained without any weight loss. Metabolic balances show excellent adjustment to the diet; all subjects were in positive balance for nitrogen and for the major inorganic constituents. All the clinical data including heart rate, blood pressure, and oral temperature were in the normal ranges and no significant differences were observed due to confinement in the Life Support Systems Evaluator. Author

N67-37620*# National Aeronautics and Space Administration, Washington, D. C.
AEROSPACE MEDICINE AND BIOLOGY—A CONTINUING BIBLIOGRAPHY WITH INDEXES, JULY 1967
Aug. 1967 167 p refs
(NASA-SP-7011(40)) CFSTI: HC $3.00/MF $0.65 CSCL 06S

In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which man is subjected during the following simulated or actual flight in the earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. Each entry consists of a standard citation accompanied by its abstract. Author

N67-37622*# IIT Research Inst., Chicago, Ill.
RESEARCH ON OXYGEN TOXICITY AT THE CELLULAR LEVEL Final Report, 15 Apr. 1965–15 Jun. 1966
Willis H. Riesen, James Q. Kissane, Raymond W. Bieber, Merl L. Kardatzke, Harold P. Kaplan (AMRL) et al Wright-Patterson AFB, Ohio, AMRL, Dec. 1966 82 p refs
(NASA Order R-87; Contract AF 33(615)-2164)
(NASA-CR-88545; IITRI-L6027-13; AMRL-TR-66-206) CFSTI: HC $3.00/MF $0.65 CSCL 06T

The use of pure oxygen atmospheres at reduced pressure in manned spacecraft has stimulated new research interest. Exposure of humans to pure oxygen at total pressures of 5 to 7 psia for up to 30 days has generally produced only subjective and occasional symptomatic distress. Nevertheless, studies with animals have clearly documented toxicity if the exposure to pure oxygen is at higher total pressures. The selection of suitable oxygen atmospheres for manned space flight and the development of protective measures against toxic manifestations will be considerably facilitated by a clearer understanding of the toxic syndrome. Rats, dogs, and monkeys were exposed to pure (98.5%) oxygen at 1 atm and 1/3 atm in a closed, recirculating chamber and in a nonrecirculating chamber. Rats exposed at a pressure of 1 atm showed significant reduction in efficiency of liver mitochondrial oxidative phosphorylation. Weight loss accompanied this change. Insignificant changes were found in liver or lung mitochondrial oxygen consumption; liver or lung NAD, NADH, or NAD/NADH; and arterial blood lactate and pyruvate, and lactate/pyruvate ratio. A composite index of oxygen toxicity was derived from a multivariant data analysis. Exposure of rats to pure oxygen at 1/3 atm showed slight elevation in P/O ratio in 7 days. The ratio returned to normal in 2 weeks and remained so for 8 months. No significant weight changes were observed. Only preliminary experiments with the dogs and monkeys were conducted. There is an indication that monkeys are more resistant to oxygen toxicity at 1 atm than rats. Author

N67-37627* National Aeronautics and Space Administration, Washington, D. C.
COACERVATE DROPS AS A FORM OF CONCENTRATION OF MATTER [KOATSERVATNYYE KAPLI KAK FORMA KONTSENTRIROVANIYA VESHCHESTV]
T. N. Yevreinova Jan. 1967 13 p refs Transl. into ENGLISH from Probl. Evolyutsionnoi i Tekhn. Biokhim., Akad. Nauk SSSR, Inst. Biokhim. (Moscow), 1964 p 118–126
(NASA-TT-F-10610) CSCL 06A

Coacervate drops are considered a form of concentration of molecules in the process of development of life on earth. The degree of concentration of matter in the individual coacervate drops of different chemical composition was determined by optical methods: quantitative interference microscopy and ultraviolet cytospectrophotometry, making it possible to find matter down to 10^{-13} g. The concentration of different substances (protein, nucleic acids, hydrocarbons, lipids) in drops exceeds by tens and hundreds

of times the concentration of matter in solutions from which the drops were formed. There are definite quantitative relations between the size of drops and the concentration of matter in them. The smaller the drops, the denser they are. Such ratios occur in some one-celled organisms and in the cells of tissues. The collected data on the content of matter in drops can be used in computing the space required for holding the molecules participating in chemical reactions modeled in coacervate drops. Author

N67-37628*# International Information, Inc., Philadelphia, Pa.
COACERVATES [KOATSERVATY]
T. N. Yevreinova Oct. 1967 34 p refs Transl. into ENGLISH from USP. Sovrem. Biol. (Moscow), v. 37, no. 2, 1954 p 177–201
(Contract NASw-1499)
(NASA-TT-F-10700) CSCL 06A

The author discusses coacervates, mainly those obtained from aqueous colloidal solutions of proteins. The information presented indicates that coacervates can be transformed into a multiple of liquid structures. The role of such liquid coacervate structures in biology is considered. It is shown that, since coacervates can be formed from the same chemical compounds which participate in the composition of living organisms, some properties of coacervates and living organisms are the same. However, coacervates can be used only as coarse models for a study of the problem of the generation of life. Author

N67-37640* Stanford Research Inst., Menlo Park, Calif.
ULTRASTRUCTURE OF THE GASTRIC MUCOSA OF NORMAL LABORATORY FERRETS
R. J. Stephens and C. J. Pfeiffer [1967] 24 p
(Contract NAS2-3559)
(NASA-CR-73136) CSCL 06C

Essential features of the ultrastructure of the gastric glandular tissue of the normal, fed, and fasted adult ferret are delineated. Data are intended to serve as a baseline for studies of the physiological and pharmacological response of the mammalian gastric mucosa. Cytological features of the surface mucous cell, parietal cell, and chief cell are described. Fine fibrils were seen running from the desmosomes on the lateral surface of surface mucous cells beneath the nucleus and on toward desmosomes on the opposite side of the cell. Mucous granules are produced in the area of the Golgi and evidence is presented that secretion is brought about by solubilization in the apical cytoplasm prior to release through the plasma membrane. Argentaffin cells with microvilli extending into the lumen of the gland were observed. Several micrographs accompany the discussion. S.P.

N67-37678* Scientific Translation Service, La Canada, Calif.
CHANGE IN MOVEMENT COORDINATION IN MAN AFTER PROLONGED CONFINEMENT IN A SMALL CHAMBER [IZMENENIYE KOORDINATSII DVIZHENIY CHELOVEKA PRI DLITEL'NOM PREBYVANII YEGO V KAMERE MALOGO OB'YEMA]
B. A. Dushkov Washington, NASA, Jul. 1967 9 p refs Transl. into ENGLISH from Kosmich. Biol. Med. (USSR), v. 1, no. 2, 1967 p 64–70
(Contract NASw-1496)
(NASA-TT-F-11139) CSCL 06S

Biodynamic structures of a complex highly automatized act (walking) and specially chosen movements were studied prior to, during and following 17- and 19-day chamber experiments. Prolonged hypodynamia was shown to disturb the cyclic interaction of structures involved in the motor act and to impair the coordination of biodynamic elements of the neuromotor apparatus in active poses. When developing physical exercises for peculiar conditions, it is recommended to take into consideration the disorders revealed in the human motor coordination (changes of the tempo and rhythm of the activity, physical efforts and pose). Author

N67-37804# Ohio State Univ., Columbus.
THE EFFECTS OF POSTURE, BREATHING PRESSURE, AND IMMERSION IN WATER ON LUNG VOLUMES AND INTRAPULMONARY PRESSURES Final Report, Jul. 1964–Jun. 1965
Leonard James Thompson (M.S. Thesis), Michael McCally (AMRL, Wright-Patterson AFB, Ohio), and A. S. Hyde (AMRL, Wright-Patterson AFB, Ohio) Wright-Patterson AFB, Ohio, AMRL, May 1967 46 p refs Supported Jointly by AMRL
(Contract AF 33(657)-11698)
(AMRL-TR-66-201; AD-655938)

Lung volumes were measured by spirometry and single breath helium dilution in five subjects under various combinations of posture, breathing pressure, and headout neutral temperature immersion. Tidal volume was unaltered. Vital capacity was reduced significantly only by negative pressure breathing during seated immersion. Seated immersion decreased total lung capacity and functional residual capacity, but the supine posture underwater partially restored these decreases. Positive pressure breathing increased total lung capacity and residual volume for the seated subject in both air and water. A wide range of transthoracic pressure gradients is subjectively more comfortable than a slight increase in the transpharyngeal pressure gradient, suggesting that during immersion, intrapulmonic pressures are selected by the subject to minimize the transpharyngeal pressure gradient. Author (TAB)

N67-37837*# Public Health Service, Phoenix, Ariz. Planetary Louarantine Unit.
SERVICES PROVIDED IN SUPPORT OF THE PLANETARY QUARANTINE REQUIREMENTS OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, JULY–SEPTEMBER 1967
M. S. Favero 10 Oct. 1967 21 p
(NASA Order R-137)
(NASA-CR-88862; Rept.-10) CSCL 06M

Comparative experiments on the recovery of microorganisms by pork infusion thioglycollate agar (PIT) and trypticase soy agar (TSA) showed that, generally TSA recovered significantly more aerobic and anaerobic sphores than PIT. Tabulated data are presented on the continuing experiments being conducted to determine: (1) the effect of rinse water temperature during storage and prior to heat shock on the recovery of bacterial spores; (2) comparative spore counts of naturally occurring airborne microbial populations on stainless steel strips with cold (4°C) and warm (25°C) peptone water used as the rinse fluid; (3) comparative D_{125C} values for naturally occurring bacterial spores from soil samples; (4) airborne viable particles per 5 cu ft within the Manned Spacecraft Operations Building and within various Apollo areas; (5) microbial contamination accumulating on stainless steel strips exposed within various Apollo areas; and (8) microbial contamination detected on the surfaces of Lunar Orbiter, Surveyor, and IMP spacecraft. M.G.J.

N67-37885*# Scientific Translation Service, La Canada, Calif.
CHANGE IN WATER-SALT METABOLISM DURING 62-DAY HYPOKINESIA [IZMENENIYE VODNO-SOLEVOGO OBMENA V USLOVIY USLOVIYAKH 62-SUTOCHNOY GIPOKINEZII]
Ye. N. Birukov, L. I. Kakurin, G. I. Kozyrevskaya, Yu. S. Koloseva, Z. P. Payek, and S. V. Chizhov Washington, NASA, Jul. 1967 7 p refs Transl. into ENGLISH Kosmich Biol. i Med., v. 1, no. 2, 1967 p 74–79
(NASA-TT-F-11141) CSCL 06P

Water-salt metabolism was studied in six healthy young men in a 62-day bed rest experiment. Prior to the experiment

subjects were exposed to accelerations of 13 to 15 g. The diet consumed provided 3000 to 3500 cal/day. The amount of water consumed, urine excreted, and the diuresis rate were investigated. The electrolytic composition of the blood, urine and feces was determined. The 62-day bed rest resulted in a decrease of water consumption, a change of the diuresis rate, and a shift of the electrolytic composition of urine and feces. The changes were of a phasic character. Two periods were distinguished in the dynamics of water-salt metabolism: (1) the stage of reconstruction covering 3 to 4 weeks, and (2) that of a relative stabilization of metabolism at the level adequate to the new conditions. Peculiarities of the shifts revealed in water-salt metabolism indicate the development of dehydration and decalcification. Author

N67-37890# Albert Einstein Medical Center, Philadelphia, Pa. Lab. of Experimental Dermatology.

EFFECT OF IONIZING RADIATION ON THE DISTRIBUTION OF DEOXYRIBONUCLEASES AND PHOSPHATASES IN SUBCELLULAR FRACTIONS OF GUINEA PIG EPIDERMIS Third Year Comprehensive Report, 14 Aug. 1964–31 May 1967

Joseph Tabachnick 31 May 1967 13 p refs
(Contract AT(30-1)-3445)
(NYO-3445-13) CFSTI: HC $3.00/MF $0.65

Progress is reported on studies on the effects of radiation on the distribution of enzymes in subcellular fractions of guinea pig epidermis. Results are summarized from studies on the effect of β irradiation of the skin on the content of 7 acid and 7 neutral or alkaline epidermal hydrolases. Only acid hydrolase was found to be increased significantly after exposure of skin to 300 rep β irradiation. These findings indicate that the release of destructive acid hydrolases is not a primary radioinduced lesion leading to the death of cells in irradiated epidermis. Histochemical evidence of the presence of lysosomes in guinea pig epidermal cells was obtained. An increase in DNase was observed in irradiated guinea pig skin and appeared to be a general response associated with cutaneous inflammation. NSA

N67-37895# Hawaii Univ., Honolulu.

STUDIES OF THE EFFECT OF IONIZING RADIATIONS ON THE PROCESSES OF CELLULAR PROLIFERATION, MEGASPOROGENESIS, AND EMBRYO-SAC DEVELOPMENT Progress Report

Yoneo Sagawa 22 May 1967 9 p
(Contract AT(04-3)-235)
(UH-235P6-3) CFSTI: HC $3.00/MF $0.65

Orchids were used to study the effect of ionizing radiations on the processes of megasporogenesis and embryo sac development. Unlike most flowering plants, megasporogenesis must be induced in orchids, and is accomplished by pollination. The stages in the processes of megasporogenesis and embryo sac development occur over a prolonged period of time (50 to 60 days) and this allows ample time to isolate and treat materials in specific stages. Results are reported from studies on the effects of exposure to 500, 7,500, or 10,000 R x radiation on fruit set of *Dendrobium phalaenopsis* type orchids examined at weekly intervals from 1 to 9 weeks after pollination. Data are included on the induction of chromosome aberrations and necrosis, cellular proliferation, embryo sac development, and megasporogenesis. NSA

N67-37924* Naval School of Aviation Medicine, Pensacola, Fla.

ENERGY DISSIPATION CHARACTERISTICS IN TISSUE FOR IONIZING RADIATION IN SPACE Progress Report, 1 Jun.–31 Aug. 1967

Hermann J. Schaefer 31 Aug. 1967 3 p
(NASA Order R-75)
(NASA-CR-88502; PR-19) CSCL 06R

Preliminary investigations and the inquiries to be undertaken are briefly outlined. It is pointed out that very little work has been done on tissue ionization dosages applicable to the inside of an SST in the 60,000 to 65,000 foot altitude. Limitations and discrepancies in published measurements are indicated. N.E.N.

N67-38006# Army Medical Research and Nutrition Lab., Denver, Colo.

ENERGY, NITROGEN, AND WATER REQUIREMENTS OF NORMAL ADULTS RESIDING AT 4300 METERS FOR 28 DAYS

C. Frank Consolazio, Le Roy O. Matoush, Herman Johnson, and Ted A. Daws Jul. 1967 27 p refs
(Rept.-308; AD-656462)

Balance studies were conducted on three groups of young, healthy adults between the ages of 18-24 years. After control studies, Group I was taken to 4300 meters gradually, Group II was taken to 4300 meters abruptly, and Group III remained at sea level during the entire study. One-half of each group were physically conditioned. No significant differences were observed in nitrogen, and fluid balances between: (a) the groups that were taken to altitude gradually or abruptly, or (b) between the groups that were physically conditioned, and those who did not exercise. As a result, the respective groups were combined for comparative purposes. Three factors were prominent during the 28 day high altitude exposure to 4300 meters that included: (a) a decrease in food intake which is probably due to anorexia caused by the clinical symptoms; (b) a negative nitrogen balance which may be due to the decreased nutrient intake and the increased requirement for energy; and (c) a negative fluid balance due to involuntary dehydration and other undetermined factors. These factors appeared to be somewhat less in Group I who ascended to altitude gradually, and suggests the beneficial effects of ascending to high altitude gradually. Author (TAB)

N67-38010*# National Aeronautics and Space Administration, Washington, D. C.

MEANS OF DETERMINING THE MAXIMUM ALLOWABLE CONCENTRATION OF TOXIC PRODUCTS OF NATURAL HUMAN METABOLISM [PUTI USTANOVLENIYA PREDEL'NO DOPUSTIMYKH KONTSENTRATSIYA TOKSICHESKIKH PRODUKTOV YESTESTVENNOGO METABOLIZMA CHELOVEKA]

V. V. Kustov Oct. 1967 4 p ref Transl. into ENGLISH from Obshchiye Vopr. Prom Toksikol. (Moscow), 1967 p 63–65
(NASA-TT-F-11358) CFSTI: HC $3.00/MF $0.65 CSCL 06P

The effect of the 7 to 8 hour action of carbon monoxide, ammonia, and acetone on certain physiological and biochemical indices in man is proposed as the basis for determining the maximum allowable concentrations for human natural metabolic products. Author

N67-38019*# Scientific Translation Service, La Canada, Calif.

EFFECT OF ACCELERATION AND HYPOKINESIA ON THE FUNCTIONAL STATE OF THE STOMACH [VLIYANIYE NEKOTORYKH EKSTREMAL'NYKH VOZDEYSTVIY NA FUNKTSIONAL'NOYE SOSTOYANIYE ZHELUDKA]

P. I. Yegorov, K. V. Smirnov, M. M. Korotayev, and M. V. Lukasheva Washington, NASA, Jul. 1967 6 p refs Transl. into ENGLISH from Kosmich. Biol. Med. (USSR), v. 1, no. 2, 1967 p 71–74
(Contract NASw-1496)
(NASA-TT-F-11140) CSCL 06S

The experiments were performed on 5 male test subjects who were twice exposed to chest-to-back accelerations of 11.9–14.5 g with an interval of 4 to 6 days. After the exposures the test subjects remained in the state of hypokinesia for 2 months after which they were re-exposed to accelerations of 11 to 16 g. The exposure to accelerations inhibited the secretory and enzyme

forming gastric functions. The acidity of the intestinal juice tended to increase. Hypokinesia conditions produced further inhibition of the stomach glands. Author

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N67-36679# Bendix Corp., Davenport, Iowa. Pioneer-Central Div.

SUBCRITICAL LIQUID OXYGEN STORAGE AND SUPPLY SYSTEM FOR USE IN WEIGHTLESS ENVIRONMENTS Final Report, 1 Jan. 1965–3 May 1966

H. Robert Lundeen Wright-Patterson AFB, Ohio, AMRL, Apr. 1967 70 p refs

(Contract AF 33(615)-2308)

(AMRL-TR-66-178; AD-655359)

A subcritical liquid oxygen storage and supply system for use in weightless environments was designed, combining the properties of the capillary-wick to displace gas phase from a two-phase mixture, thus assuring liquid phase delivery, with the dominant surface tension forces which cause liquid phase to accumulate at the periphery and gas phase to locate at the center of a spherical container in a weightless environment. A 10-liter prototype unit was fabricated based on these concepts. The complete system includes, in addition to the storage container, associated temperature, pressure, acceleration, and strain sensors to monitor system performance in weightless conditions. Liquid phase delivery from the pressure vessel has been demonstrated by the oxygen-nitrogen mixed gas test technique. The testing program conducted on the prototype unit gave every indication that the design concept is satisfactory for weightless operation. Author (TAB)

N67-36688# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.

EFFECTS OF PRIMARY TASK PERFORMANCE ON RESPONSE TIME TO TOGGLE SWITCHES IN A WORKSHOP CONFIGURATION Technical Report, Oct. 1965–Feb. 1966

Earl D. Sharp Apr. 1967 42 p refs

(AMRL-TR-66-190; AD-655770)

The study was designed to determine interaction effects of central tracking performance and performance on variously located toggle switch controls. Subjects were required to operate toggle switches located in various positions to their left while maintaining control of a primary tracking task. Performance times for toggle switch operation and absolute integrated error scores corresponding to each toggle switch location were collected and analyzed. The results indicated that: (a) Variation of toggle switch location had no effect on tracking performance. (b) Vertical displacement of toggle switch controls affected only the reach time, while angular displacement affected only the manipulation time. The results of this study were compared with the results of a study completed earlier which used a centrally located fixation point rather than a tracking task. With the tracking task substituted in place of the fixation point, the reaction time (the time to release the starting switch) to secondary control operations decreased. Author (TAB)

N67-36710*# Sandia Corp., Albuquerque, N. Mex.

PRINCIPLES OF OPERATION OF THE VACUUM PROBE MICROBIOLOGICAL SAMPLER

V. L. Dugan Aug. 1967 26 p refs

(Contract NASA Order R-09-019-040)

(NASA-CR-88381; SC-RR-67-688) CFSTI: HC $3.00/MF $0.65

CSCL 06B

This paper contains the detail drawings which describe the physical design of the vacuum probe, which has been designated the "hand probe" or the "filter probe", and a suggested protocol for the repeated use of this instrument. Also included are a discussion of how the probe's critical orifice varies with atmospheric pressure and vacuum pressure and how small particles may be influenced by the sonic noise which is produced by the operation of the orifice. Author

N67-36723# Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.

A COMPUTER SIMULATION EXPERIMENT OF SUPERVISORY CONTROL OF REMOTE MANIPULATION

Simon G. McCandlish Apr. 1967 76 p refs

(Contract AF 19(628)-3317)

(DSR-79960-5; ESD-TR-67-290; AD-655375)

The long term aim of this work is the modeling of the process by which the human commands and controls a real-time information system containing automatic subroutines which may be used to accomplish portions of the task. Remote manipulation is believed to have all the typical attributes of such a system yet be simple enough to be amenable to laboratory investigation. This report describes a computer simulation of a remote manipulation task and rate-controlled manipulator; into the latter was built some low-level automatic decision making ability which could be used at the operators discretion to augment his direct continuous control. Under experimental investigation were the effect of transmission delay, dynamic lag and intermittent vision on human manipulative ability. This report describes further experiments in which the operator called in sequence various on-site automatic control programs of the machine, and thereby acted as a supervisor. The results suggest that the supervisory mode of operation has some advantages when the task to be performed is difficult for a human controlling directly. Results show the supervisory mode to require more training than the direct mode. TAB

N67-36727# Federal Aviation Agency, Oklahoma City, Okla.

A PROTECTIVE PASSENGER SMOKE HOOD

Ernest B. McFadden, H. I. Reynolds (Schjeldahl (G. T.) Co.), and Gordon E. Funkhouser Apr. 1967 14 p refs

(AM-67-4) CFSTI: HC $3.00/MF $0.65

Several recent jet transport accidents have focused the attention of the aviation industry upon smoke and toxic gases as causal factors of passenger incapacitation and failure to evacuate aircraft before fire and heat render the environment uninhabitable. If it were possible to provide passengers with a short duration supply of breathing air sufficient to maintain the passengers' mobility and allow completion of aircraft evacuation, survival would be enhanced. Simple, light-weight, bag-shaped hoods incorporating a neck seal were fabricated of a thin pliable, high-temperature, transparent, polyimide plastic film. Polyimide film has no melting point but reportedly chars at 1500°F. In a more advanced design, thin transparent metallic coatings were applied to the polyimide film in order to reflect up to 90% of the radiant heat. Upon exposure to a specific infra-red heat flux, facial skin temperatures of 114–115°F were recorded on twelve human subjects wearing the non-metalized hood. Under identical conditions, skin temperatures of the same subjects wearing the metalized hood did not exceed 99°F. Capability of the hood to provide short term and extended protection from smoke and flame inhalation in a fire environment is discussed. Author

N67-36780# Authority Health and Safety Branch, United Kingdom Atomic Energy Authority, London (England).
THE STANDARDISATION OF PRESSURISED SUITS
W. A. Langmead Harwell, Eng. Jun. 1967 22 p refs
(AHSB/RP/-R-76) CFSTI: HC $3.00/MF $0.65

Described is the work toward specification of standards for light-duty pressurized suits and blouses, personnel air hoses, air-line hoods, oversuits, and connecting fittings. The main effort was to establish a standard PVC pressurized suit. Covered in this study are existing PVC pressurized suits, basic design principles, properties of PVC materials, and costs. Also briefly discussed are the results of operational testing of prototype PVC pressurized suits, blouses, and hoods, and the changes in design that were made following the tests. K.W.

N67-36805# Block Engineering, Inc., Cambridge, Mass.
INVESTIGATION OF INTERFEROMETRY FOR THE ANALYSIS OF ENCLOSED HABITABLE ATMOSPHERES Final Report, Dec. 1965–Dec. 1966
Richard N. Briskman and Jacob Morris Weinberg Wright-Patterson AFB, Ohio, AMRL, Feb. 1967 201 p refs
(Contract AF 33(615)-3374)
(AMRL-TR-66-236; Rept.-8360; AD-655396)

To develop a small and highly sensitive optical spectrometer for providing repeatable qualitative and quantitative analysis of contaminant gases in enclosed habitable atmospheres, a feasibility study and measurements program was conducted. An infrared interferometer spectrometer was employed in conjunction with a gas absorption cell for trace gas analysis. During the program, spectra were taken of 43 compounds, 10 binary, 10 trinary, 5 five-order, and 1 fifteen-order mixture. Typical minimum detectable concentrations range from 1 to 40 mg/l. The results of this program have defined a system that will satisfy the criteria for a prototype flight instrument. Author (TAB)

N67-36806# Naval Air Development Center, Johnsville, Pa. Aerospace Medical Research Dept.
TEMPORAL AND LUMINOUS CALIBRATION OF THE NAVY FLASHBLINDNESS TRAINING DEVICE
Gloria T. Chisum 30 Jun. 1967 17 p *ref*
(NADC-MR-6706; AD-655435)

Temporal and luminance measurements of the energy output of the Navy flashblindness training device developed by BioTechnology, Inc. were made by personnel of the U. S. Naval Air Development Center. The purposes of these measurements were to determine the temporal characteristics of the flash, the spectral distribution of the visible portion of the energy, the illumination at the cornea and on the retina of an observer. Plots are given in the report which show the results of these measurements. Results indicated that the illumination produced by the flash source at the corneal plane is 637.8 lumen-seconds/sq cm. Author (TAB)

N67-36834*# Army Natick Labs., Mass. Advanced Projects Div.
EXPERIMENTAL STUDY OF A PASSIVE THERMAL CONTROL SYSTEM FOR SPACE SUITS Status Report, 17 Jan.–17 Jul. 1967
Ferdinand Votta, Jr. 24 Jul. 1967 17 p
(NASA Order R-135)
(NASA-CR-88546; SR-9) CSCL 06K

A design concept was tested under simulated space conditions, and its operating characteristics were studied using various materials of constructions. The proposed system requires an impermeable membrane and a permeable membrane which need not be selective. The features of the system include a skin separated from the impermeable membrane by a narrow air gap controlled by a spacing material. The air gap keeps the skin dry and contains the life support gas at the required pressure, while the impermeable membrane prevents the escape of the life support gas. The covered impermeable membrane is in contact with a wet wick which itself is covered by a permeable membrane. The permeable membrane is separated from an outer impermeable membrane by a porous vapor space vented to space through a pressure control valve. Cooling is thus obtained by the controlled diffusion of water vapor through the permeable membrane and vaporization of the water into the vapor space. The results indicate that it is possible to design a passive thermal control system which will remove heat from a man in a space suit at rates in excess of 3000 Btu/hr without depending on sweating, maintaining the man in a relatively dry environment. K.W.

N67-36846# Michigan Univ., Ann Arbor. Human Performance Center.
COGNITIVE FACTORS IN INFORMATION PROCESSING
Paul M. Fitts Feb. 1967 34 p refs Presented at the XIV Intern. Congr. of Psychology, Washington, D. C., 26 Aug. 1963 Sponsored by ARPA
(Contract AF 49(638)-1235)
(AFOSR-67-1802; MEMO-1; AD-656714)

The general framework proposed to use in interpreting human information-processing behavior is that of a program for processing data. The term program as used in this report has essentially the same meaning, and is presumed to serve a similar function, as does the program which governs an electronic data-processing system or any organization of people engaged in a complex task or production. Reference to the analogy between human functions and a stored-program computer, as various writers have emphasized, permits us to talk about alternative processes or procedures for operating on data in complex ways, independently of the particular data on which these operations are performed or the particular system that is processing the data. Author (TAB)

N67-36847# Army Natick Labs., Mass. Clothing and Organic Materials Div.
ELECTRICALLY HEATED HANDWEAR
Herman Madnick and Alice Park Mar. 1967 23 p refs *Its* Ser. C&ED-46
(TR-67-82-CM; AD-656742)

Electrically heated handwear is presented as a solution to the hand-protection problem for equipment operators and other military personnel who must use their hands in extremely cold conditions for prolonged periods. The problem of hand cold injury, the inadequacy of conventional solutions and existing handwear, and various experimental approaches are discussed. The U.S. Army Natick Laboratories has assembled an auxiliary electrical handwear system and is continuing research efforts to improve electrically heated handwear. It is concluded that because of the demonstrated need for such handwear and the current feasibility of manufacturing it, electrically heated handwear should be supplied to the appropriate personnel. Author (TAB)

N67-36861# Air Force Systems Command, Wright-Patterson AFB, Ohio. Aerospace Medical Research Labs.
A STUDY OF SIMULATOR CAPABILITIES IN AN OPERATIONAL TRAINING PROGRAM Final Report, May 1965–Aug. 1966
Donald E. Meyer, Ralph E. Flexman, E. A. Van Gundy (FAA), David C. Killian (United Airlines Training Center), and C. J. Lanahan (Airline Pilots Assoc.) May 1967 54 p
(AMRL-TR-67-14; AD-656308)

The experiment was conducted to determine the effects of simulator training to criterion proficiency upon time required in the aircraft. Data were also collected on proficiency levels attained, self-confidence levels, individual estimates of capability and sources from which that capability was derived. Subjects for the experiment

were 48 airline captains transitioning into the DC-8 aircraft. The subjects were equally assigned to experimental and control treatment groups. Subjects in the experimental group were trained in the DC-8 simulator for as much time as required to satisfy their instructors that they could perform the required maneuvers in the simulator at the same level of proficiency required to pass the final qualifications check in the aircraft. The control group was trained using the standard curricula which required a fixed time in the simulator. Data obtained from student reactions to questionnaire items are interpreted to indicate that: (1) simulators can be used to further reduce requirements for training time in aircraft; and (2) simulators can be used to evaluate performance that is indicative of performance in the aircraft. Author (TAB)

N67-36870# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
A QUANTITATIVE THEORY OF RECOGNITION
Alex Grumet Sep. 1967 83 p refs
(RE-303) CFSTI: HC $3.00/MF $0.65

A universal quantitative measure of recognition is defined in terms of resolvable units of the feature of the object to be recognized and the sensor that perceives it. Parameters normally associated with recognition such as range, noise, sensor, resolution, and environment of background are included in the recognition measure. Feature recognition, object recognition, and processor recognition are defined and examples are given of each. Recognition noise is defined, and the effect of noise on recognition is shown to be equivalent to a reduction of resolution. The relationship between the quantitative recognition measure and autocorrelation theory, as well as decision theory, are discussed. Application of the recognition measure to the solution of mathematical expressions is demonstrated. Author

N67-36895# Naval School of Aviation Medicine, Pensacola, Fla.
MORALE AS A FUNCTION OF SELF-DEFINITION AND STAGE OF TRAINING
George M. Rickus and Rosalie K. Ambler 15 May 1967 14 p refs
(NAMI-1007; AD-655818)

Seven hundred and seven naval aviation trainees from three stages of training were administered an anonymous questionnaire that asked them to give their own definition of morale. They were then instructed to rate their own morale on a ten-point scale using their definition as a frame of reference. A content analysis of the definitions identified the following categories: task oriented, group oriented, and self oriented. Mean morale rates were obtained for the subjects falling in each of the definitional categories and stages of training. The results showed that morale increased as trainees progressed from pre-flight to basic flight training, that morale level varied as a function of the definition expressed, and that the definition expressed was a function of the stage of training experienced. Author (TAB)

N67-36897# Mitre Corp., Bedford, Mass.
STUDIES IN DISPLAY SYMBOL LEGIBILITY. PART XVIII: THE RELATIVE LEGIBILITY OF UPPERCASE AND LOWER CASE TYPEWRITTEN WORDS
Glen C. Kinney and Diana D. Showman Jun. 1967 43 p refs
(Contract AF 19(628)-5165)
(MTR-394; ESD-TR-67-106; AD-655798)

The relative legibilities of common words typewritten in all-uppercase and all-lowercase letters were studied in three experiments. Human subjects identified the words shown one at a time for a short period. All-uppercase printing was found to be significantly more legible than all-lowercase in all three experiments. The word-form of all-lowercase words was not found to influence word identification. The use of uppercase letters is recommended for displays. Author (TAB)

N67-36984# Bendix Corp., Davenport, Iowa.
REGENERATIVE CARBON DIOXIDE ADSORPTION SYSTEM USING CHARCOAL Final Report, 1 Apr. 1965–30 Sep. 1966
Peter Wildermuth Wright-Patterson AFB, Ohio, AMRL May 1967 53 p
(Contract AF 33(615)-2443)
(AMRL-TR-67-48; AD-656786)

A system was designed and built for testing activated charcoal as a regenerative carbon dioxide adsorbent in an atmosphere involving oxygen pressures of 240-275 mm Hg. The system gas flow rate was 160-340 liters/minute. The gas stream was composed of oxygen, humidified to 50%. Carbon dioxide was added to simulate the production rate of two men. Because of the sub-atmospheric operation, the system was a closed loop design and any carbon dioxide not adsorbed on the first pass through the charcoal continued to circulate through the system. The charcoal was subjected to an ambient room temperature of approximately 27C, and the gas stream controlled at 26.7 plus or minus 2.7C during the adsorption testing. Regeneration of the charcoal was by vacuum. The testing program demonstrated that charcoal will continue to adsorb carbon dioxide at a significant rate after repeated cycling with no apparent change or degradation. The presence of water vapor in the gas stream tends to reduce the capacity of the charcoal for adsorbing carbon dioxide. However, it is readily removed from the charcoal by vacuum and exhibits no cumulative effect on the carbon dioxide adsorptive capacity of the charcoal. Author (TAB)

N67-36991*# California Univ., San Diego. Visibility Lab.
COMPUTERIZED VISIBILITY CALCULATIONS MAXIMUM SIGHTING RANGE PROGRAM
Ivan Harry Barkdoll III Jul. 1967 126 p refs
(NASA Order R-139; Contract NObs-92058)
(NASA-CR-88157; AD-655470) CFSTI: HC $3.00/MF $0.65
CSCL 05H

The report describes the development of computer programs for the performance of visibility calculations. The computer programs use input data as to the directional reflectance properties of both object and background to determine the inherent contrast of the object for a particular path of sight. Atmospheric contrast transmittance for the path of sight is calculated from input atmospheric data in the form of path luminance and beam transmittance. The inherent contrast is then multiplied by the contrast transmittance to find the apparent contrast. These calculations are repeated for selected distances from the object to determine that range at which the apparent contrast of the object matches the contrast threshold for the human visual system for the angular subtense of the object as viewed at that distance, and for the adaptation level specified. The vision data used in the calculation is the Tiffany data and represents best visual performance, in that the stimulus duration was long, the observers knew where the object was located, and the observers were allowed to fixate in any manner of their choosing. Therefore, ranges calculated from this vision data are called maximum sighting ranges. The computer program described in this report calculates maximum sighting ranges for 57 paths of sight defining hemispherical volume within which the object can be detected. TAB

N67-37029*# Louisville Univ., Ky.
A CODE TRANSFORMATION TASK THAT PROVIDES PERFORMANCE MEASURES OF NONVERBAL MEDIATION (COTRAN)
Earl A. Alluisi and Glynn D. Coates Washington, NASA, Sep. 1967 43 p refs
(Grant NGR-18-002-008)
(NASA-CR-895) CFSTI: HC $3.00/MF $0.65 CSCL 05H

A code-transformation (COTRAN) task has been designed to follow the model of the problem-solving paradigm. The task is intended to provide performance measures of that part of intellectual functioning which is typically called "nonverbal mediation." In the

first experiment, 90 subjects worked at the COTRAN task under one of a set of six conditions which represented the factorial combination of two memory-aid and three transformation-complexity conditions. Seventy-two measures of COTRAN performance were factor analyzed, and five COTRAN factors were identified. Nine measures were selected to represent the five factors, and with these measures it was found that performance with two memory aids was better than with one. The factorial structure was the same under the two conditions. In the second experiment, 84 subjects each completed 18 COTRAN problems as well as a set of paper-and-pencil tests of intellectual abilities and personality. A factor analysis of the 75 measures used resulted in the identification of five COTRAN factors (the same as in the first experiment) and three additional factors—one for verbal intelligence, and two for personality characteristics. Author

N67-37030*# Whirlpool Corp., St. Joseph, Mich.
INVESTIGATION OF THE FEASIBILITY OF WET OXIDATION FOR SPACECRAFT WASTE TREATMENT
Robert B. Wheaton, J. R. Calloway Brown, Ruben V. Ramirez, and Norman G. Roth [1966] 43 p refs
(Contract NAS1-6295)
(NASA-CR-66450; Rept.-66450) CSCL 06K

Laboratory studies were made to determine the feasibility of adapting the principle of high temperature, high pressure, wet oxidation to the reclamation of water and the disposition of organic waste residues on board space vehicles. The process assures the balance of the water cycle and is a possible first step in the conversion of waste materials into reusable forms. The tests were conducted in a one liter oxidation chamber using pure oxygen. The effects of oxidation temperature, catalysts, influent concentration, stirring, and similar variables were studied during the wet oxidation of a variety of waste materials. Author

N67-37045# Michigan Univ., Ann Arbor. Dept. of Psychology.
CHOICE REACTION TIME: AN ANALYSIS OF THE MAJOR THEORETICAL POSITIONS
Edward E. Smith Jan. 1967 90 p refs
(Contract AF 49(638)-1235)
(AFOSR-67-1804; TR-6; AD-656713)

The report analyzes and evaluates (against experimental findings) contemporary theories of choice reaction time (CRT). The influence of Donders subtraction method on current theory is assessed, followed by a review of experimental findings concerned with the effects on CRT of: (1) number of alternatives, (2) stimulus probability, (3) stimulus value, (4) repetition of stimulus or response, (5) stimulus discriminability, (6) stimulus-response compatibility, (7) practice, and (8) emphasis on speed versus accuracy. A three-state conceptualization of the central mechanisms operative during the latent period--stimulus preprocessing, stimulus categorization, and response selection--is proposed. The theories are dichotomized on the basis of the process-template matching versus feature testing--which is assumed to underlie stimulus categorization. The analysis indicates that current theories have neglected response selection processes and are consequently unable to account for several experimental findings. A final section deals with the relation of CRT theories to perceptual recognition theories. Author (TAB)

N67-37077# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
INTEGRATED LIFE SUPPORT SYSTEM STUDY (20-DAY EVALUATION PROGRAM) Final Report, Apr.–Dec. 1965
Courtney A. Metzger and Eugene Fritz Dec. 1966 76 p refs
(AMRL-TR-66-185; AD-656311)

Tests were conducted to define the various problems involved in the maintenance of an acceptable environment, the number of variables concerned with the man-machine concept, the operation, maintenance and evaluation of single units and integrated systems for the support of life in a simulated aerospace mission. The investigation covered primary problems and benefits associated with water recovery, personal hygiene, sanitation, nutrition, instrumentation, atmospheric conditions at various pressures and mixtures, clothing, crew accommodations, waste management and muscle-strength while confined in a chamber simulating an aerospace vehicle, and the facilities and support required to test and evaluate life support systems. Author (TAB)

N67-37090# Army Aeromedical Research Unit, Fort Rucker, Ala.
SOUND ATTENUATION CHARACTERISTICS OF THE NAVY SPH-3 (MODIFIED) (LS) HELMET
Robert T. Camp, Jr. and Robert L. Keiser May 1967 25 p
(USAARU-67-8; AD-656748)

An evaluation of the real-ear sound attenuation characteristics of the Navy SPH-3 (Modified) (LS) Helmet was done with procedures and equipment specified by ASA Z24.22 - 1957. The results show that the SPH-3 (Modified) (LS) is a relatively efficient attenuator of sound throughout the audio spectrum. In view of the poor sound attenuation characteristics of the Army APH-5, it has been recommended that this helmet be replaced by the SPH-3 (Modified) (LS). Author (TAB)

N67-37320*# Douglas Aircraft Co., Inc., Santa Monica, Calif.
ENGINEERING CRITERIA FOR SPACECRAFT CABIN ATMOSPHERE SELECTION
M. S. Bonura and W. G. Nelson Washington, NASA, Sep. 1967 300 p refs
(Contract NASw-1371)
(NASA-CR-891) CFSTI: HC $3.00/MF $0.65 CSCL 06K

Test results and analytical data are presented to show the effects of atmosphere selection on life support system design. These indicate: (1) Comfort zones are 5° to 7°F higher in helium–oxygen atmospheres than in nitrogen–oxygen. (2) Normal space cabin leakage involves a higher weight flow rate when nitrogen is the diluent. (3) In evaluating the airlock penalty, a pump-down system for atmosphere conservation is considered advantageous if used more than three to six times a mission. (3) Heat exchangers, condensers, and absorption beds will require approximately equal weight and power for equal heat loads and operating temperatures. (4) Experimental data were applied to an example problem for a three-man orbital laboratory. Findings show that a weight and power savings can be obtained by using helium as a diluent. (5) Ignition and combustion phenomena of cotton cloth, a single insulated wire, and wide bundles were assessed under various typical atmospheres. In general, increasing diluent concentration results in decreased burning rates, while increased oxygen partial pressure decreases ignition temperature. Author

N67-37356# Los Alamos Scientific Lab., N. Mex.
A PERSONNEL RADIO-FREQUENCY RADIATION MONITOR
Frederic L. Fey, Jr. 12 Jul. 1967 5 p ref
(Contract W-7405-ENG-36)
(LA-3722) CFSTI: HC $3.00/MF $0.65

A personnel radio frequency radiation monitor was developed which indicates exposure to significant rf radiation by an audible chirp. The chirp rate is proportional to the power flux level down to an adjustable threshold which may be set as low as 0.1 mW/cm^2. When this monitor is worn by a person, the threshold could be set at 10 mW/cm^2 to conform with the working level suggested by the American Standards Association. The rf monitor circuit is composed of inexpensive and readily available components contained in a case the size of a cigarette package, yet it is stable and reliable. At a low chirp rate, it can operate continuously for 1 month on a small 4.2-volt mercury battery. This monitor would be valuable in guarding against overexposure and injury of

personnel working in facilities where there are high power sources of rf energy, such as radio transmitters, particle accelerators, and radar installations. Author (NSA)

N67-37389# Duke Univ., Durham, N. C. Medical Center.
CARDIOPULMONARY EFFECTS OF PRESSURE BREATHING DURING HYPOTHERMIA Final Report
John Salzano and F. G. Hall Wright-Patterson AFB, Ohio, AMRL, Apr. 1967 22 p refs
(Contract AF 33(657)-8854)
(AMRL-TR-66-184; AD-655935)

Continuous pressure breathing was studied in hypothermic anesthetized dogs. Alveolar ventilation decreased during continuous positive pressure breathing (CPPB) and increased during continuous negative pressure breathing (CNPB). The changes in alveolar ventilation were due to changes in respiratory rate as well as in respiratory dead space. Cardiac output fell significantly during CPPB due to a reduction in heart rate and stroke volume. During CNPB cardiac output was only slightly greater than during control as a result of a fall in heart rate and an increase in stroke volume. Oxygen consumption was reduced to 60% of control during CPPB of 16 cm H2O, but was 25% greater than control during CNPB. Qualitatively, CO2 production changed as did O2 consumption, but was different quantitatively during CNPB, indicating hyperventilation due to increased respiratory rate. Mean pulmonary artery pressures and pulmonary resistance varied directly with the applied intratracheal pressure. The results indicate that the hypothermic animal can tolerate an imposed stress such as CPPB and can increase its O2 consumption during CNPB as does the normothermic animal. Author (TAB)

N67-37391# Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.
INVESTIGATION OF AN INTEGRATED CARBON DIOXIDE-REDUCTION AND WATER-ELECTROLYSIS SYSTEM Final Report, 1 Jan.–30 Jun. 1966
John E. Clifford, Edwin S. Kolic, Edward W. Winter, Robert H. Cherry, and Eugene J. Mezey Wright-Patterson AFB, Ohio, AMRL, Apr. 1967 74 p refs
(Contract AF 33(615)-2288)
(AMRL-TDR-66-186; AD-655937)

A new integrated system for oxygen recovery from carbon dioxide was investigated. Experimental studies indicated that it was feasible to integrate water electrolysis with carbon dioxide hydrogenation in an electrolysis cell using PD-25AG hydrogen-diffusion cathodes containing Sabatier catalyst. A closed system producing carbon appeared feasible from experiments on catalytic methane cracking followed by hydrogen separation from unreacted methane in an electrolytic hydrogen-concentration cell using PD-25AG electrodes. A small experimental breadboard system was designed and constructed. Author (TAB)

N67-37438# Michigan Univ., Ann Arbor. Dept. of Psychology.
HUMAN PERFORMANCE IN CONTINGENT INFORMATION PROCESSING TASKS
Irving Biederman (Ph.D. Thesis) Oct. 1966 110 p refs Sponsored by ARPA
(Contract AF 49(638)-1235)
(AFOSR-67-1801; TR-3; AD-656712)

Theoretical accounts of complex human information processing behavior have emphasized the utilization of contingencies whereby the processing of some information directs the processing requirements of the remaining sources of uncertainty. The manner in which such contingencies are processed, however, has received little empirical study. The present investigation examined the effects of discriminability and S-R compatibility on the speed and accuracy of response in tasks in which the relevancy of a given stimulus dimension was contingent upon the value of the stimulus on some other dimension. It was concluded that contingencies are utilized by the subject to select dimensions to process. Further, these contingencies are utilized at some stage prior to that involved in the selection of responses. RTs to a repeated stimulus were faster than RTs to a different stimulus. The magnitude of these repetition effects varied as a function of the discriminability of the dimension that changed value, its relevancy, and its structural status. Author (TAB)

N67-37439# Michigan Univ., Ann Arbor. Engineering Psychology Lab.
CONSERVATIVE INFERENCE WITH SIMPLE AND DIFFUSE HYPOTHESES Final Report
Ward Edwards Aug. 1967 9 p
(Contract AF 49(638)-1731)
(Rept.-08024-7-F; AFOSR-67-1877; AD-656781)

A large number of experiments have evaluated the manner in which men make inferences about hypotheses on the basis of fallible data. The most important conclusion of these experiments is that man is a conservative information processor, unable to extract as much information as is latent in the data. The research reported further investigates the phenomena of conservative information processing. Author (TAB)

N67-37646# General Electric Co., Schenectady, N. Y. Research and Development Center.
IMMOBILIZED LIQUID MEMBRANES FOR CONTINUOUS CARBON DIOXIDE REMOVAL Final Report, 24 May 1966–1 Sep. 1966
W. J. Ward, III Wright-Patterson AFB, Ohio, AMRL, Jun. 1967 49 p refs
(Contract AF 33(615)-2957)
(S-67-1076; AMRL-TR-67-53; AD-656785)

The objective of the program was the development of an immobilized liquid membrane for CO2 removal from a manned spacecraft. During basic film research, water was found to be better than a polymeric material or any pure liquid for CO2/O2 separation. An immobilized film of water was available in the form of a porous cellulose acetate membrane. By impregnating this membrane with a concentrated solution of CsHCO3/Cs2CO3, and a catalyst for the hydrolysis of CO2, CO2 transport was facilitated and O2 transport was decreased to obtain a CO2/O2 separation factor and CO2 permeability of 4100 and 55. 796 x 10 to the -9th power. A mathematical analysis of CO2 transport was also carried out. It will now be possible to build a single-stage CO2 removal system with minimum power, weight, and size requirements. Author (TAB

N67-37685# Michigan Univ., Ann Arbor. Dept. of Psychology.
HUMAN PERFORMANCE IN INFORMATION PROCESSING AND STORAGE Final Report
Arthur W. Melton Jul. 1967 72 p refs
(Contract AF 49(638)-1235; ARPA Order 461)
(AFOSR-67-1874; AD-656709)

Research was conducted in the general field of Engineering Psychology, and specifically on human performance. This research is designed to produce a taxonomy of human information-processing functions, to determine human capabilities and limitations in fulfilling basic information-processing functions, to develop a model of human short-term memory in the interest of advancing basic knowledge of human information processes. TAB

N67-37689# Space-General Corp., Los Angeles, Calif. Center for Research and Education.
ELECTROCHEMICALLY ACTIVE, FIELD-TRAINABLE PATTERN RECOGNITION SYSTEMS Final Report, 1 Feb. 1966–30 Apr. 1967

R. M. Stewart, J. R. Milne, G. I. Hickey, and C. E. Hendrix Apr. 1967 84 p refs *Its* Res. on Adaptive Devices
(Contract Nonr-4416(00))
(SGC-485/FR-3; AD-655650) CFSTI: HC $3.00/MF $0.65

Research was directed toward the development of a new class of pattern recognition equipment for rapid and automatic detection and/or classification of spatio-temporal patterns. One restricted but key class of systems was emphasized--functionally, adaptable linear decision functions; structurally, a homogeneous array of gold/iron dipoles in nitric acid which feed, in parallel, a low-impedance detector circuit--and means for direct excitation of such arrays by patterns of incident light. Theory shows that such a system (and some others) can be trained through the agency of diffuse or global electrical shocks applied across the whole array immediately following each improper response in a training sequence and, thus, avoid the conventional requirements for detailed access, connecting, or internal structuring and programming. During this process the size and structure (and, hence, function) of the dendrites is gradually altered in excited regions through differential dendritic electrodeposition and dissolution. When perfected and extended, this type of bulk process and others like it should lead to pattern recognition machines reaching entirely new levels of packing density and versatility. Additional design data was acquired through a number of basic experiments and completed an experimental sixteen-element Linear Field-Trainable (LIFT) array was completed together with compatible pattern input, control, and monitoring equipment. TAB

N67-37578# Naval School of Aviation Medicine, Pensacola, Fla.
PSYCHOMOTOR FUNCTIONS, THE BODY IMAGE, AND AVIATION
Gary L. Tucker and Roger F. Reinhardt 8 Dec. 1966 23 p refs
(NAMI-986; AD-655434) CFSTI: HC $3.00/MF $0.65

In the evaluation of aviators, and particularly student aviators, another source of anxiety -- unrelated to fears of death and mutilation, etc. -- has become evident. This is in the sphere of psychomotor adaption to the process of flying an airplane. In this report, a theoretical formulation of the process of learning to fly is presented in terms of the aviators psychomotor function, body image, and ability to orient himself in space. Clinical and experimental evidence are presented to validate these theories. Author (TAB)

N67-37599# Life Sciences, Inc., Fort Worth, Tex.
PILOT PERFORMANCE, TRANSFER OF TRAINING AND DEGREE OF SIMULATION. II. VARIATIONS IN AERODYNAMIC COEFFICIENTS
N. C. Ellis, A. L. Lowes, W. G. Matheny, D. A. Norman, and L. E. Wilkerson Orlando, Fla., Naval Training Device Center, May 1967 115 p refs
(Contract N61339-1889)
(NAVTRADEVCEN-1889-1; AD-655837)

Transfer of training studies were conducted to determine the training feasibility of simulations reduced by varying aerodynamic coefficients in two ways, rigid coefficients and least squares approximations to the coefficients. Experiment One incorporated the coefficient changes in the longitudinal mode; Experiment Two in the lateral mode; and Experiment Three in the combined longitudinal and lateral modes. On the basis of study results, it was concluded that feasibility of these reduced simulations as conditions for training was demonstrated. Author (TAB)

N67-37654*# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
ADVANCES IN THE USE OF COMPUTERS FOR HANDLING HUMAN FACTORS TASK DATA
Lawrence E. Reed Apr. 1967 16 p refs Submitted for publication
(NASA Order PR-115)
(NASA-CR-88560; AMRL-TR-67-16; AD-656701) CSCL 06B

The purpose of the paper is to review some of the data problems the analyst must deal with in his work and to suggest some possible remedies. A review of the task analysis procedures is followed by a discussion of the uses of task analysis in system development programs. Problems connected with each were used to generate the goals of a research program, which is directed toward the development of computerized techniques to assist the analyst make better use of available data. Author (TAB)

N67-37687*# Case Inst. of Tech., Cleveland, Ohio. Digital Systems Lab.
A COMPUTER-AIDED CONTROL TECHNIQUE FOR A REMOTE MANIPULATOR
Jon Terry Beckett 1967 146 p refs
(Grant NsG-728)
(NASA-CR-88483) CFSTI: HC $3.00/MF $0.65 CSCL 05H

A technique for controlling a remote manipulator is investigated which utilizes a general purpose digital computer to assist the operator in performing complex tasks with a minimum of information. An experimental computer-controlled manipulation system is described and several path and positioning control algorithms are presented. One position control algorithm minimizes the manipulator transit time and automatically directs the manipulator around all predefined obstacles. An executive program allows the operator to control the manipulator in the manual mode, to utilize a semi-automatic mode in which commands are entered through a teletype console, or to transfer control to an automatic mode executive routine which reads a series of commands from paper tape and automatically executes them. Author

N67-37707# Naval Medical Research Inst., Bethesda, Md.
THE DEVELOPMENT AND USE OF THE PRIMARY AFFECT SCALE (PAS) Research Report
Eugene Johnson, III, and Thomas I. Myers Jul. 1967 19 p refs
(Rept.-1; AD-655651)

Ten verbal self-report scales were developed to measure subjective affect or feelings in five a priori areas: Happiness, Anger, Fear, Depression, and Arousal. Choice of measurement model, scaling procedures, and use of the scales are discussed. Author (TAB)

N67-37714# Mitre Corp., Bedford, Mass.
STUDIES OF DISPLAY SYMBOL LEGIBILITY. PART XVI: THE LEGIBILITY OF TELETYPEWRITER SYMBOLS ON TELEVISION
G. L. Bell Bedford, Mass., ESD, Apr. 1967 51 p refs
(Contract AF 19(628)-5165)
(MTR-388; ESD-TR-67-104; AD-655356)

The legibility of long Gothic and Murray teletype symbol fonts was studied on television. Subjects identified light symbols on a dark background at four resolutions. The results showed that three special cloud-cover symbols were illegible for all resolutions studied. Under ideal conditions, 10 active lines per symbol height was the minimum recommended resolution for the alphanumeric symbols. The long Gothic and Murray symbols were equally legible. It is recommended that more legible symbols be used for the three cloud-cover conditions. Author (TAB)

N67-37729 Aeronautical Research Council (Gt. Brit.).
THE THERMAL ASSESSMENT OF PERSONAL CONDITIONING GARMENTS
D. R. Burton 1967 42 p refs Supersedes RAE-TR-65263; ARC-28385
(ARC-CP-953; RAE-TR-65263; ARC-28585) HMSO: 7s 6d

This paper discusses the thermal behavior of personal conditioning garments both in theory and practice. A general equation, which is developed for the case of the convective air ventilated suit supplied with cool air, is modified for the cases of the water conditioned suit, and the air ventilated suit with warm dry air supplies. Results of past experiments at the Institute of Aviation Medicine and the Royal Aircraft Establishment are reviewed with the aid of this theoretical approach. It is concluded that there is a need for more systematic experimental data on personal conditioning, especially on convective air cooling. The broad outline of a possible experimental program is discussed. The potential performance of convective, evaporative, and liquid conditioning is predicted; but in view of the scarcity of useful data the results, which are presented in graphical form, are considered to be very tentative. Author

N67-38033*# Astro Research Corp., Santa Barbara, Calif.
SOME CONSIDERATIONS OF MANNED EXTRAVEHICULAR ACTIVITIES IN ASSEMBLY AND OPERATION OF LARGE SPACE STRUCTURES
H. Schuerch Washington, NASA, Sep. 1967 22 p
(Contract NAS7-427)
(NASA-CR-871; ARC-R-217) CFSTI: HC $3.00/MF $0.65 CSCL 05H

Concepts are formulated by which man's extravehicular activities in assembly and operations of space structures can be placed into perspective. Man's outstanding capability of adaption, intelligent anticipation, and dexterity are identified as primary components of his usefulness in this function. These capabilities are considered in view of their use in specific phases of space programs, varying from the initial development phases to the operation of matured systems. Author

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N67-36689# California Univ., Santa Barbara. Dept. of Chemistry.
ELECTRONIC SPECTRA OF AZA-AROMATICS IN POLYMER MATRICES
E. H. Park, A. H. Kadhim, and H. W. Offen Jul. 1967 27 p refs Submitted for publication
(Contract N00014-67-A-0120-0001)
(TR-4; AD-655464)

The absorption and fluorescence of acridine, phenazine, their cations, and phenazine-di-N-oxide were studied in polymer matrices. The correspondence to spectra in liquid or frozen solutions is established for the polymer matrices. The effect of the matrix and compression (0-27 kbar) on the spectral properties are compared. The extent of solid solvent perturbation on spectral location and bandwidth is illustrated for acridine and phenazine. The red shifts of the absorption and fluorescence band maxima are compared for two polymer matrices. The magnitude of the pressure response of the fluorescence bands and intensities differs for degassed and nondegassed plastic solutions. Author (TAB)

N67-36692*# Battelle Memorial Inst., Columbus, Ohio.
DEVELOPMENT OF CHEMICAL ANALYSIS TECHNIQUES FOR ADVANCED MATERIALS Quarterly Progress Report, Apr. 17–Jul. 16, 1967
E. R. Blosser 3 Aug. 1967 25 p Prepared for JPL
(Contracts NAS7-100; JPL-951578)
(NASA-CR-88493; QPR-2) CFSTI: HC $3.00/MF $0.65 CSCL 07B

Primary emphasis during this quarter was directed toward hydroxyl determination in brucite, $Mg(OH)_2$, employing a graphite-crucible high-temperature induction furnace; thermogravimetric analysis was also used to study brucite. Chemical techniques were used to standardize several elements in Fisher M-300 samples. The carbon content of MgO was studied as a function of heating and storage conditions. Author

N67-36704# Bureau of Mines, College Park, Md. Metallurgy Research Center.
ELECTRODEPOSITION OF THICK COATINGS OF PLATINUM AND PALLADIUM ON REFRACTORY METALS FROM AQUEOUS ELECTROLYTES
Stephen D. Cramer, Charles B. Kenahan, Richard L. Andrews, and David Schlain Sep. 1967 68 p refs
(BM-RI-7016)

The objective of the present studies was to develop thick adherent and coherent coatings of platinum and palladium on refractory metals and other substrates of industrial and engineering importance. Existing platinum and palladium electrolytes were modified to make them suitable for the electro-deposition of thick deposits. The optimum operating conditions for these electrolytes were established. Pretreatment procedures for columbium, copper, graphite, molybdenum, nickel, stainless steel, tantalum, titanium, tungsten, vanadium, and zirconium substrates were studied. New pretreatment procedures for columbium, molybdenum, stainless steel, tantalum, tungsten, and nickel were developed. The internal stress and hardness of selected electrodeposits were measured. The effects of heat treatment upon the properties of electrodeposits were studied. Author

N67-36731# Pratt and Whitney Aircraft, East Hartford, Conn.
INVESTIGATION OF MECHANISMS FOR ELECTROCHEMICAL CATALYSIS Final Report, 1 May 1966–30 Apr. 1967
John R. Aylward and Stanley W. Smith Jul. 1967 66 p refs
(Contract DA-28-043-AMC-02205(E))
(PWA-3108; ECOM-02205-F; AD-656468)

A program was conducted to investigate the mechanisms of electrocatalysis with respect to the anodic oxidation of selected fuels by novel electrocatalysts in acid electrolyte at temperatures below 150C and at ambient pressure. A limited number of materials (interstitial compounds) were screened for corrosion resistance and catalytic activity, but the major emphasis was given to the study of the electrochemical properties of select transition metal silicides, since previous work had indicated some catalytic activity with these materials for fuel oxidation. The effect of surface doping the silicides with trace amounts of platinum and gold was also studied, and in addition the effect of trace amounts of platinum on the catalytic activity of gold surfaces was investigated. The silicides by themselves were found to have only slight catalytic activity for the oxidation of hydrogen or methanol, but, when combined with trace amounts of platinum they showed considerable activity. Investigations on TiSi2, WSi2, MoSi2, VSi2 and TaSi2 showed that their electrochemical behavior was related to crystal structure. Experiments with platinum-doped TiSi2 electrodes indicate that relatively large amounts of platinum are required to obtain a catalytic activity which approaches that of an equivalent platinum sheet and that the utilization of the platinum is low. The oxidation of hydrogen on both smooth gold and gold black gave a limiting current density which decreases at potentials above 250 mv. TAB

N67-36732* National Aeronautics and Space Administration, Washington, D. C.

SOLUBILITY OF HYDROGEN IN LIQUID NITROGEN AND OF HELIUM IN LIQUID HYDROGEN AS GIVEN BY DATA ON NUCLEAR MAGNETIC RESONANCE [ROZCHYNNIST' VODNYU U SKRAPLENOMU AZOTI TA HELIYU U SKRAPLENOMU VODNI ZA DANYMY YADERNOHO MAHNITNOHO REZONANSU]

I. V. Matyash, V. V. Mank, and M. G. Starkov Dec. 1966 7 p refs Transl. into ENGLISH from Ukr. Fiz. Zh. (Kiev), v. 11, no. 5, 1966 p 497–501
(NASA-TT-F-10602) CSCL 07D

This paper describes a method and the equipment for studying the solubility of gases in fluids by using the effect of nuclear magnetic resonance (NMR). It presents data resulting from a study of the solubility of hydrogen in liquid nitrogen at 77°K in the pressure range from 0 to 8 atm and of helium^3 in liquid hydrogen in the temperature range of 17.2–24°K and pressure of 0–9 atm. Author

N67-36738*# Stanford Research Inst., Menlo Park, Calif.

ANALYTICAL CHEMISTRY INSTRUMENTATION: A SURVEY

J. S. Whittick, R. F. Muraca, and L. A. Cavanagh Washington, NASA, 1967 141 p refs
(Contract NASr-49(10))
(NASA-SP-5083) CFSTI: HC $3.00/MF $0.65 CSCL 07D

Instrumentation developed under the sponsorship of NASA from 1959 through 1964 are reviewed, emphasizing the advances resulting from the constraints of space and planetary environments. Methods for the detection of energy of various wavelengths include X-ray, infrared, and ultraviolet spectroscopy, alpha-particle scattering, and neutron activation analysis. Development and applications of mass spectroscopes and gas chromatographs are reviewed, along with vaccum gauges, pumps, and other vacuum equipment. Instruments for the detection of life in space and on planets are discussed. Techniques for analyzing planetary surfaces, atmospheres, and life by remotely operated instrumentation are identified. N.E.N.

N67-36743# Michigan Univ., Ann Arbor. Dept. of Geology and Mineralogy.

STUDY OF POLYTYPIC PHASE RELATIONS AMONG COMPLEX INORGANIC STRUCTURES Semiannual Report, 1 Nov. 1966–30 Apr. 1967

Donald R. Peacor Jul. 1967 13 p refs
(Contract DA-28-043-AMC-01338(E))
(ECOM-01338-4; Rept.-07325-4-T; SAR-4; AD-656497)

Three-dimensional intensity data were measured for the plumboferrite substructure. These data result in a minimum function which confirms that the plumboferrite structure is a derivative structure of that of magnetoplumbite which in turn is isotypic with Ba-ferrite, $BaFe_{12}O_{19}$. A new set of three-dimensional intensity data for nigerite similarly shows that the nigerite structure is a derivative of the spinel structure. Further work on senaite led to one relatively complete trial structure. Detailed progress on all three of these structures determinations is described. Author (TAB)

N67-36777# Aerospace Corp., El Segundo, Calif. Labs. Div.

MASS SPECTROMETRIC DETECTION OF LABILE HYDRIDES FORMED BY ATOMIC HYDROGEN REACTIONS

Bernard Siegel and Peter Breisacher May 1967 30 p refs
(Contract AF 04(695)-1001)
(TR-1001(2210-10)-3; SSD-TR-67-103; AD-655376)

The applicability of time-of-flight mass spectrometric techniques to the study of highly labile inorganic molecules is described, with emphasis on metal hydrides. The principal techniques used in this laboratory to generate such species for mass spectrometric study are mercury photosensitization, metal evaporations in hydrogen atmospheres, and electrical wire explosions. The apparatus is described and data are given for representative chemical systems for each of these methods of generating labile species. Finally, a brief survey is given of presently unknown hydride molecules that might prove amenable to study by these techniques. Author (TAB)

N67-36808# Colorado Univ., Boulder.

THE SYNTHESIS OF SPECIAL FLUORINE-CONTAINING MONOMERS Semiannual Report, 1 Dec. 1966–1 Jun. 1967

J. D. Park and J. R. Lacher Jul. 1967 46 p refs
(Contract DA-19-129-AMC-869(N))
(TR-68-5-CM; AD-655537)

Research on the synthesis of fluorine containing olefins and diolefins is reported. Dimerization reactions aimed at producing dibox compounds are of particular interest. Reactions of note were those between 1,1,2,2-tetrafluorobutadiene 1,3 and difluorodihaloethylene followed by dihydrohalogenation with alkali to yield 2,2-dihalo-3,3,3,4,4,4-octafluoro bicyclobutenes. Methods of dehydrohalogenations applied to these reactions make available a number of dienes in good yield. Codimerization of these dienes is being continued. Author (TAB)

N67-36852# Midwest Research Inst., Kansas City, Mo.

THE MASS SPECTROMETRIC DETECTION OF DIMERS OF NITRIC OXIDE AND OTHER POLYATOMIC MOLECULES Summary Technical Report

Thomas A. Milne and Frank T. Greene 24 Jul. 1967 10 p refs
(Contract Nonr-3599(00))
(AD-655454)

Previous studies with AR (see AD-637 177) have shown that the empirical extrapolation of the AR dimer mole fraction to zero orifice size gives a value quite close to that obtained from equilibrium calculations. Such a result with AR led to the hope that the other weakly interacting gases could be sampled at high pressures (where higher-cluster equilibria are favored), with extrapolation against orifice size being used to correct for nucleation effects during expansion. However, the polyatomic gases appear to behave quite differently. This behavior is discussed in terms of possible reasons for the low observed mole fractions of polyatomic dimer. The support that the no results give for Fontijn and Rosner's postulate that clusters are involved in the anomalous (NO) X+O reaction rates is then briefly mentioned. TAB

N67-36854 Royal Aircraft Establishment, Farnborough (England).

METHODS FOR PHOSPHORUS DETERMINATION IN ORGANIC COMPOUNDS ON THE CENTIMILLIGRAM SCALE

A. J. Christopher and T. R. F. W. Fennell May 1967 19 p refs
(RAE-TR-67115)

Four mineralization procedures and an alternative spectrophotometric finish have been assessed by comparison with those of a method previously reported for the determination of phosphorus in organic compounds. It is concluded that this earlier method is superior to all others considered for the analysis of unfluorinated compounds. Suitable, but rather less satisfactory, methods for the determination of phosphorus in fluorocompounds are suggested. Author

N67-38860# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
THE CHEMISTRY OF THE X-7 (ORGANIC) LOOP COOLANT. PART I: MAY 1960 TO APRIL 1965
J. L. Smee Jan. 1966 91 p refs
(AECL-2527)

The coolant used during the reporting period was Santowax OM containing a nominal 30% high boilers or high molecular weight decomposition products. A serious problem in the fouling of fuel element heat transfer surfaces was overcome by continuous purification of the coolant by Attapulgus clay and filters. Since clay purification has been in use, the fouling rate has been less than 0.2 $\mu g.cm^{-2}.h^{-1}$ (10 μm per year). Control of the fouling promoter chlorine was accomplished by completely excluding it from the vicinity of the loop. Any which does get into the coolant is removed by a bed of Mg ribbon and Pd pellets. Since such a bed has been in use, the Cl content of the coolant has been less than 3 ppm. Also given are: (1) a brief history of the loop since its inception in 1959, (2) the effect of the clay column on the coolant chemistry, (3) a complete description of the current purification, degas, and make-up circuits, and (4) a summary of the coolant chemistry during all fuel irradiations. Author

N67-38912# Tyco Labs., Inc., Waltham, Mass.
CORRECTION FOR DOUBLE LAYER CHARGING DURING STRIPPING OF ADSORBED LAYERS
S. B. Brummer May 1967 21 p refs Submitted for publication
(Contract N00014-66-C-0210)
(ITR-1; AD-656044)

The differential double layer capacity for electrodes covered with adsorbed layers is usually lower than for the clean electrode in the base electrolyte. Because of this, there is a wide belief that subtracting the base electrolyte capacity leads to a significant over-correction for double layer charging in estimating adsorbate coverages by stripping methods. It is shown that no error occurs if charge integration both for the base electrolyte and for the adsorbate-containing solution is carried out from the respective points of zero charge (PZC) to a potential where no adsorption occurs. In practice, with solid electrodes, a small under-correction for double layer effects (1 - 3%) is introduced because the PZC is not readily experimentally accessible. Large double layer charging errors can occur on analyzing the kinetics of the stripping process, however, to overcome these, a novel experiment involving the measurement of the double layer capacity during the stripping process was suggested. Whilst the zero frequency capacity is the most appropriate for adsorbate analysis, it cannot be measured in practice. The experiment suggested allows use of the infinite frequency capacity, which is experimentally accessible. Author (TAB)

N67-38918# TRW Systems, Redondo Beach, Calif.
VOLTAMMETRIC STUDIES OF NON-AQUEOUS SYSTEMS Semiannual Report, 1 Jul.–31 Dec. 1966
O. Paez, E. T. Seo, and H. P. Silverman Apr. 1967 99 p refs
(Contract DA-28-043-AMC-02464(E))
(ECOM-02464-1; SAR-1; Rept.-1; AD-655271)

Voltammetric studies of the reduction of organic compounds in organic solvents were undertaken as part of a program to develop high-energy density organic electrolyte batteries. Cyclic voltammetry was used as a major diagnostic tool for evaluating organic oxidizing agents as possible high-energy density cathode materials, and to elucidate the mechanisms of a heterogeneous electron transfer and any homogeneous follow-up chemical reactions. The report covers the study of various nitroaromatic compounds, cyclic voltammetric current-potential curves and their interpretation are presented for a number of selected nitroaromatic compounds. The effects of methyl-, halo-, and hydroxy-groups on the electroreduction process were demonstrated. Compounds studied included m- and p-dinitrobenzene, 2,5-dinitrophenol, m-dinitrotoluene, 1-chloro-2,6-dinitrobenzene and nitroalkanes. The addition of lithium ions was shown to have a beneficial effect on organic reductions under selected conditions. Author (TAB)

N67-38924# Atomic Energy Commission Research Establishment, Lucas Heights (Australia).
THE DETECTION AND ESTIMATION OF INDIUM-114m IN EFFLUENT
R. Porritt Feb. 1967 14 p refs
(AAEC/TM372) CFSTI: HC$3.00/MF$0.65

A simple method for the quantitative determination of indium-114m in effluent is described. Five liters of effluent is scavenged with ferric hydroxide and the indium-114m determined by gamma spectrometry. The method is rapid, economical of operator time, and is applicable down to concentrations of 2×10^{-4} $\mu Ci/l$ and lower. Author

N67-38958# Institut zu Nuklearne Nauke (Boris Kidric), Belgrade (Yugoslavia).
TALC DEHYDRATION KINETICS
Snezana Boskovic, Miroslav Gasic, Branislav Zivanovic, and Momcilo M. Ristic *In its* Bull. of the Boris Kidric Inst. of Nucl. Sci., Vol. 17, No. 2 1966 p 113–124 refs (See N67-36954 22-34)

Talc dehydration is a typical example of solid state reaction in which solid state and gaseous products are formed. From the viewpoint of present-day theories this problem has been approached by analyzing kinetic parameters to show that the talc dehydration is a two-stage process. The activation energy of the first and second stages is 15.1 kcal/mol and 50.2 kcal/mol, respectively. Author

N67-38977# Army Natick Labs., Mass. Clothing and Organic Materials Div.
A REVIEW OF PHOTOCHROMISM IN TRIPHENYLMETHANE DERIVATIVES AND RELATED COMPOUNDS
Richard N. Macnair Jan. 1967 51 p refs
(C+OM-29; TR-67-51-CM; AD-654798)

A comprehensive review of photochromism in triphenylmethane derivatives and some related compounds is presented. Most of the individual compounds reported to be photochromic as well as some of those reported as non-photochromic are mentioned. Compounds were included only if the conditions under which the observations were made were reasonably well described. In preparing the review little attention was given to the degree of photochromism reported since very little quantitative data are available. Physical properties of the compounds and/or their solutions which appear to be related to photochromism are discussed including conductivity, dielectric constant and dipole moment. Among other topics discussed are mechanisms and kinetic studies. Author (TAB)

N67-38985# Bureau of Mines, Albany, Oreg. Metallurgy Research Center.
A STATISTICAL EVALUATION OF SOME FACTORS IN THE PREPARATION OF BORON BY FUSED-SALT ELECTROLYSIS
James H. Russell and Hal J. Kelly Oct. 1967 21 p refs
(BM-RI-7028)

A statistical approach was used to evaluate the effects of temperature, current density, and composition of the electrolyte

on the purity of boron prepared by electrolysis of a fused mixture of boric oxide in potassium fluoborate. The quadratic equation which best fits the data was calculated for a temperature of 650° to 850°C, a cathode current density of 40 to 1,150 amp/ft^2, and a boric oxide content of 0.3 to 7.1 molal. The best products, better than 95 percent boron, were obtained when the current density was less than 2 amp/ft^2 and the boric oxide content was less than 2 molal. Author

N67-36992# Harry Diamond Labs., Washington, D. C.
THE THERMAL REACTION BATTERY. ELECTROLYTES FROM THE PYROLYSIS OF OXIME DERIVATIVES
Fred M. Dewey Jun. 1967 29 p refs
(HDL-TR-1351; AD-655834)

Organic compounds that can be thermally degraded to yield permanently liquid solvents for ionizable salts are being sought for use in electrolytes for the proposed thermal reaction battery. Several oximes, oxime esters, and oxime ethers were prepared and pyrolyzed. Some of the pyrolyses were rapid at temperatures near 200C, most success being attained with aldoxime esters. Evidence thus far indicates that an acceptable pyrolysis rate can be obtained at these or lower temperatures using Lewis-acid catalysts or at higher temperatures using high-boiling materials. Prior conductivity measurements have indicated that solutions of inorganic salts in the pyrolysis products of oxime esters will give specific conductances sufficient for the proposed thermal reaction battery. Author (TAB)

N67-36998# Louvain Univ. (Belgium). Lab. for Inorganic Chemistry.
EXPERIMENTAL STUDY OF CHEMI-IONIZATION Final Scientific Report, 1 May 1965–30 Apr. 1967
A. Van Tigeelen and S. De Jaegere May 1967 45 p refs
(Grant AF-EOAR-67-82)
(ARL-67-0155; AD-656343)

Ions were identified and their concentration was measured for an atmospheric methane-oxygen flame. The ion-electron recombination coefficient was derived: a = 1.9 plus or minus 0.0000001 cu cm/sec. Reaction mechanisms responsible for the ion formation are proposed. The rate constant of the electron-transfer reaction K + H3O (+) to K (+) + H2O + H was evaluated: ke = 4.6*x 10 to the -8th cu cm/sec. The number of ions produced per carbon atom was evaluated for the mentioned flame as a function of the equivalence ratio and of the flame temperature. The accuracy and the measuring range of the apparatus for flash conductimetry was greatly improved. A description is given of these improvements. The determination of electron concentrations from flashconductimetric data is discussed. Ion-electron recombination reactions were studied in explosive methane-oxygen-nitrogen dioxide mixtures. A recombination coefficient of 4.25 x 0.0000001 cu cm/sec is suggested for the recombination of NO(+) with electrons. Author (TAB)

N67-37004# Harvard Univ., Cambridge, Mass. Dept. of Chemistry.
THE OXIDATION AND PYROLYSIS OF ETHYLENE IN SHOCK WAVES
John B. Homer and G. B. Kistiakowsky Jul. 1967 28 p refs Submitted for publication
(Contract Nonr-1866(36))
(AD-656040)

The oxidation of C2H4 was studied in a shock tube by monitoring the infrared emissions from CO and CO2 and the visible emission from CH*. The characteristics of this oxidation closely resemble oxidations of C2H2 and C2H2 + H2. The induction periods and exponential time constants for the early phase of CO formation are the same for all three oxidations over the temperature range of 1500K to 2300K and lead to a common activation energy of 17 +1 or -1 kcal/mole. Above 1800K, the C2H4 - O2 reaction, in its early stages, consists mainly of the pyrolysis of C2H4, and the concurrent oxidation of pyrolysis products, C2H2 and H2. Later in the reaction, and more prominently so at lower temperatures, the reaction changes in character to a slower direct oxidation of C2H4. The relative rates of CO and CO2 production in both C2H4 - O2 and C2H2 - O2 reactions are reported as a function of temperature. The pyrolysis of C2H4 was also studied in the shock tube by an infrared technique and its rates determined between 1950K and 2250K. The results give an activation energy of 52 kcal/mole for the reaction. The oxidation results would indicate that C2H4, above 1800K, decomposes mainly by a molecular rather than a radical mechanism. Author (TAB)

N67-37026*# Grace (W. R.) and Co., Clarksville, Md. Research Div.
SYNTHESIS OF LINEAR, DOUBLE CHAIN LADDER POLYMERS FROM SUBSTITUTED TETRAPHOSPHONITRILES Final Report, 3 May 1966–15 May 1967
Bernard Grushkin, Robert M. Murch, Thomas Bieniek and Theodore S. Soddy 15 May 1967 56 p refs
(Contract NASw-1415)
(NASA-CR-88613) CSCL 07C

The thermal deammoniation of β-*trans*-[OPN(NH$_2$)]$_4$ was studied. The highest molecular weight polymers were obtained when the reaction was conducted at 265°C. Satisfactory polymers were not obtained when the condensation was conducted in a high-boiling solvent. Several new β-*trans*-tetraphenylcyclotetraphosphonitriles were prepared. Among those prepared were tetraazide, a tetramethylamino, a tetraisothiocyanate, and a tetramethoxymethylamino. The thermally induced polymerizations of the tetraazide and tetramethylamino cyclics were studied. Neither cyclic led to polymers with desirable properties. Attempts were made to copolymerize β-*trans*-[OPNCl]$_4$ with toluene 2,4-diisocyanate, with pyromellitic tetraacid chloride, and with pyromellitic dianhydride. No high-molecular weight polymers having desirable properties were obtained from these copolymerizations. During the study of the thermally induced deammoniation of β-*trans*-[OPN(NH$_2$)]$_4$ a new type of polymer was discovered. Polymers containing transition metal cations coordinated with the tetraaminophosphonitrile cyclics were prepared, and their chemical and physical properties were studied. Author

N67-37044# Battelle Memorial Inst., Columbus, Ohio.
FORMATION OF ALKALI IRON SULFATES AND OTHER COMPOUNDS CAUSING CORROSION IN BOILERS AND GAS TURBINES Summary Report No. 2, Jan. 1–Jun. 30, 1967
30 Jun. 1967 57 p refs
(Contract NObs-94516)
(AD-656366)

The question of the relative importance of SO3 and of SO2 + O2 in flue gas in forming the complex sulfates that lead to corrosion has been answered by recent work with radioactive sulfur as a tracer. These test have shown that SO3 even in low concentrations is much more reactive. Additional measurements of the reaction of SO2 + O2 on catalytic surfaces now confirm that ample SO3 can be formed at the surface at a low gas velocity to account for the formation of the trisulfates. Such low gas velocities may exist on surfaces in boiler furnaces and gas turbines beneath layers of deposits. Trace amounts of trisulfates now can be detected by an optical technique, and also an electrochemical device was developed that appears capable of indicating the onset of corrosion within a few minutes after establishing corrosive conditions. Author (TAB)

N67-37047# Tyco Labs., Inc., Waltham, Mass.
RESEARCH ON THE ELECTROCHEMICAL OXIDATION OF HEXANE AND ITS ISOMERS Semiannual Interim Report No. 2, 16 May–15 Nov. 1966
S. B. Brummer 15 Nov. 1966 47 p refs
(Contract DA-44-009-AMC-1408(T))
(AD-656496)

The mechanism of the adsorption and oxidation of C3H8 and n-C6H14 on smooth Pt electrodes from 12M H3PO4 at 130C was studied using potentiostatic step and galvanostatic pulse techniques. Initial adsorption of n-C6H14 occurs as virtually unchanged hydrocarbon at a diffusionally controlled rate. Subsequently, the adsorbed hydrocarbon reacts to form three types of adsorbed product - O-type, CH-alpha, and CH-beta. O-type n-C6H14 is similar to O-type C3H8 and to the product formed on Pt in the presence of CO2, reduced CO2. CH-beta, which has a low oxidation state and releases upwards of 4 electrons per site on oxidation, is unreactive both towards oxidation and towards reduction. It is probably a carbonaceous polymer. CH-alpha, which also has a low oxidation state, is relatively unreactive towards oxidation but can be readily reduced. It is probably a mixture of partially dehydrogenated alkyl radicals. The relation of these adsorbed species to the over-all hydrocarbon-to-CO2 reaction is discussed. TAB

N67-37068# Atomic Energy of Canada, Ltd., Pinawa (Manitoba).
THE CHEMISTRY OF THE X-7 (ORGANIC) LOOP COOLANT. PART II: APRIL 1965–MAY 1966
J. L. Smee Jul. 1966 19 p refs
(AECL-2654; Pt. II) Available from Atomic Energy of Canada Ltd., Pinawa: $0.50

The coolant chemistry during the X-726 fuel irradiation is described. This was the first fuel irradiation in HB-40. The fouling potential remained $\leq 0.2\ \mu g.cm^{-2}.h^{-1}$ throughout the test and other impurities were acceptably low. The high boiler content increased from 2% to 12% during the irradiation. No problems were encountered during the changeover from Santowax OM to HB-40. Author

N67-37084*# Monsanto Research Corp., Everett, Mass. Boston Lab.
TEST EVALUATION OF FUEL CELL CATALYSTS Quarterly Report, 15 Feb.–15 May 1967
R. F. Drake, S. Matsuda, and B. P. Sullivan 20 Jun. 1967 12 p
(Contract NASw-1527)
(NASA-CR-88547; MRB5012Q1) CFSTI: HC $3.00/MF $0.65
CSCL 07D

The first group of compounds was tested for catalytic activity in the oxidation of dextrose and N_2H_4. These compounds were interstitial compounds of iron. Results indicated that no compounds were catalytically active for dextrose oxidation in buffered neutral electrolyte, but all compounds were sufficiently active for N_2H_4 oxidation in KOH electrolyte. Some compounds, particularly those prepared from leached Raney iron, however, showed significantly severe corrosion in the caustic electrolyte. Author

N67-37092# Little (Arthur D.), Inc., Cambridge, Mass.
THE ENERGETICS OF ION TRANSPORT IN THE PRESENCE OF POLYMERIC COMPOUNDS WHICH ALTER THE RHEOLOGICAL PROPERTIES OF WATER
R. A. Horne, H. F. Eden, and R. P. Young 11 Aug. 1967 7 p refs
(Contract Nonr-4424(00))
(TR-30; AD-656058)

The Arrhenius activation energy of the electrical conduction of aqueous 0.10M KCl solution remains unchanged when a thickening agent such as polyvinylmethel ether or a drag-reducing agent such as polyethylene oxide is added, indicating that these agents, in the small amounts added, probably do not appreciably alter the structure of liquid water. Author (TAB)

N67-37096# Purdue Univ., Lafayette, Ind. Dept. of Chemistry.
ULTRATRACE ANALYSIS BY COORDINATION CHAIN REACTIONS Final Report, 1 Nov. 1964–31 Oct. 1966
Dale W. Margerum Jul. 1967 8 p refs
(Grant AF-AFOSR-134-65)
(AFOSR-67-1792; AD-656339)

A summary is given of work intended to explore the analytical capabilities of a unique catalytic system including (1) ultratrace determination of metal ions, (2) selective ultratrace analysis, (3) automation of the method and (4) coupling of the reaction system in order to detect other trace species. In addition fundamental studies of the factors affecting the exchange rate of ligands coordinated to metal ions was continued. The application of this new kinetic method to ultratrace analysis was accomplished. As little as 10 to the -8th power M metal ions can be determined with 10% accuracy using manual techniques. Automatic measurement of the reaction rate constant permits analysis at the 0.01 ppm level within a few minutes. Stopped-flow mixing and an automated readout converts the transient photometric signal to a parameter which is a function of the trace metal present in the sample. The method is applicable to any metal capable of complexing EDTA. With pH control and the addition of masking agents the selective determination of metals is shown. The presence of 10 to the -8th power moles of dissolved O2 in water was detected by coupling reactions of O2 to the coordination chain reaction system. Author (TAB)

N67-37117# Princeton Univ., N. J. Frick Chemical Lab.
PHYSICAL AND MECHANICAL PROPERTIES OF POLY-M-CARBORANYLENESILOXANE COPOLYMERS
Leslie H. Sperling, Emmanuel J. Zaganiaris, and Arthur V. Tobolsky Jun. 1967 16 p refs
(Contract Nonr-1858(07))
(ONR-TR-RLT-98; AD-656049)

The physical and mechanical properties of a series of random copolymers of SiB-1 and SiB-2 were investigated. Modulus-temperature data yielded Tg, the glass transition temperature, Tm, the melting temperature, and Tox, the temperature of rapid oxidative crosslinking. Stress relaxation and weight loss data were also obtained on selected copolymers. These copolymers all have outstanding high temperature properties, which improve with lowered SiB number. Author (TAB)

N67-37142# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CHEMICAL STABILITY OF TITANIUM IN HYDROHALIC ACIDS AND HALOIDS [KHIMICHESKAYA STOYKOST' TITANA V GALOIDOVODORODNYKH KISLOTAKH I GALOIDAKH]
Kh. L. Tseytlin, L. L. Fayngol'd, and V. 'A. Strunkin *In its* Phys. Met. of Titanium 30 Dec. 1966 p 250–267 refs (See N67-37121 22-17)

The present paper considers the effect of halogens on the chemical stability of titanium in halo acids. Titanium corrodes insignificantly in halo acids at room temperature, but at 90°C corrosion reaches tremendous proportions. In all cases, addition of

halogens to hydrochloric and hydrobromic acids was found to lower the corrosion rate of titanium, although increasing the temperature lowered the protective capacity of the halogens. Chlorine, bromine and iodine decreased the corrosion of titanium to the same degree. Tests by the authors showed that VTI titanium sheets ignite in chlorine gas at room temperature after 24 hours. Strong corrosion was observed with iodine at 60°C. Other tests indicated that titanium reacts rapidly with both dry liquid bromine and moist bromine, although it has high stability in this respect about titanium. Test by the authors showed that almost all nitro compounds sharply lower the corrosion rate of titanium by hydrochloric acid up to 60°C. Author

N67-37143# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INFLUENCE OF SODIUM NITRITE ON THE CORROSION OF TITANIUM IN HYDROCHLORIC AND SULFURIC ACIDS [VLIYANIYE NITRITA NATRIYA NA KORROZIYU TITANA SOLYANOY I SERNOY KISLOTAMI]

Yu. I. Sorokin and Kh. L. Tseytlin *In its* Phys. Met. of Titanium 30 Dec. 1966 p 268–279 refs (See N67-37121 22-17)

The effect of sodium nitrite on titanium corrosion by 20% HCl and H_2SO_4 was investigated using VTI-1 titanium sheets suspended in a thermostat with or without mixing. The tests indicated that titanium has satisfactory stability in 20% hydrochloric and sulfuric acids at 0 and 10°C. Increasing the temperature increased titanium corrosion in hydrochloric acid and 20% sulfuric acid. Addition of low concentrations of nitrite passivated the titanium in HCl and H_2SO_4 better than the addition of nitrous acid. This is due to the formation of nitro oxides by the nitrites. Addition of sodium nitrite passivates titanium in 20% HCl and H_2SO_4 at 20° and 60°C, while at 100°C it greatly lowers corrosion. The addition of sodium nitrite results in a positive potential on the titanium surface, satisfactory stability of the titanium being ensured in 20% HCl and H_2SO_4 with 0.01% $NaNO_2$ at 20°C and with 0.1% $NaNO_2$ at 60°C. Author

N67-37190# Johns Hopkins Univ., Baltimore, Md. Dept. of Chemistry.

HIGH RESOLUTION STUDIES IN THE FAR INFRARED Final Report

Dean W. Robinson Jun. 1967 12 p refs
(Contract AF 49(638)-1430)
(AFOSR-67-1607; AD-655799)

A study was made of the far infrared spectra at liquid helium temperatures. At low temperatures rotational modes of vibrations become librational. A spherical environment was produced by condensing water and hydrogen fluoride in rare gas matrices. Pure crystals of polyatomic molecules such as hydrogen sulfide and iodide were studied. Solid solutions of water and deuterium oxide in rare gases were studied. Marked improvements were accomplished in a far infrared detector which operates at 1.5 Kelvin and in the construction of a low temperature infrared cell. Author (TAB)

N67-37276# Texas Univ., Austin. Defense Research Lab.

AN ELECTROKINETIC STUDY OF THE PLATINUM–POTASSIUM IODIDE SOLUTION INTERFACE

Jerre T. Anderson 1 May 1967 118 p refs
(Contract Nonr-3579(02))
(DRL-A-280; AD-656726)

The linear phenomenological laws as applied to electrokinetic effects are used to (1) show that problems arising from surface conductance may be avoided; (2) show that ac bridge measurements of the conductance of an electrokinetic system may lead to incorrect results; (3) develop characteristic curves for electrokinetic energy converters. It is shown that one of the linear equations is valid for the platinum-potassium iodide system. A general equation for the zeta potential-streaming current relation valid for porous media is developed. Evidence is adduced for the assignment of a Freundlich isotherm to the Gouy-Chapman surface charge at the platinum-potassium iodide solution interface whereas previous work indicates that the adsorption of iodide follows a Temkin isotherm. For a particular model the surface charge is related to surface dipole moment. A method of determining the isotherm for zeta potential determining species is proposed. Author (TAB)

N67-37286# Harvard Univ., Cambridge, Mass.

OPTICAL POTENTIAL FOR A CHEMICALLY REACTIVE SYSTEM

B. C. Eu and John Ross (MIT) Jul. 1967 18 p refs Presented at a Meeting of the Faraday Soc., Toronto, Sep. 1967
(Contract Nonr-3623(00); Proj. Squid)
(MIT-40-P; AD-656638)

The optical potential is investigated for a chemically reactive system, K + CH3I, with an assumed potential of interaction among the three species, K, I, CH3. The complex optical potential satisfies an integral equation with a kernel related to the solution of the threebody problem, as given by Faddeev. In order to obtain some information on the form of the optical potential without numerical analysis, a number of approximations are introduced. The imaginary part of the optical potential, which gives rise to absorption (reactive and inelastic collisions), is with these approximations essentially a delta function of the KI distance. The real part of the optical potential is similar in form to the repulsive potential estimated from elastic scattering experiments on this system. Author (TAB)

N67-37342# Sussex Univ., Brighton (England). Chemical Lab.

ALUMINUM–NITROGEN AND ALUMINUM–PHOSPHORUS POLYMERS Final Report, 1 Oct. 1964–30 Sep. 1966

Anthony R. Cullingworth, Keith Gosling, J. David Smith, and Donald Wharmby Wright-Patterson AFB, Ohio, AF Mater. Lab., Jun. 1967 29 p refs
(Grants AF-EOAR-77-64; AF-EOAR-88-65)
(AFML-TR-67-69; AD-655807)

The products of the reaction between methylamine and trialkylaluminiums were studied by molecular weight determinations as well as by infrared and nuclear magnetic resonance spectroscopy. Stereoisomers of (R2A1NHR)3 are indicated. The reactions of phosphine adducts of organoaluminium compounds were studied and an order of base strength with respect to triethylaluminium was established by displacement reactions. Polymers of composition (RA1PR)x were prepared but crystalline products were obtained. Aluminium-nitrogen seem to be more stable than corresponding aluminium-phosphorus frameworks. Author (TAB)

N67-37351# Bureau of Mines, College Park, Md.

ELECTRODEPOSITION OF IRIDIUM FROM FUSED SODIUM CYANIDE AND AQUEOUS ELECTROLYTES

R. L. Andrews, C. B. Kenahan, and David Schlain Sep. 1967 17 p refs
(RI-7023)

Means of electrodepositing iridium were investigated to form thick coatings suitable for the protection of such metals as tungsten and molybdenum, which oxidize rapidly at high temperatures. Using a fused sodium cyanide bath, thick, adherent, and coherent deposits of iridium up to 15 mils thick were plated

on tungsten and molybdenum substrates at 600°C and current densities of 10 to 100 ma/cm^2. Limited oxidation testing of molybdenum encapsulated with pure iridium indicates that the coating may offer protection to approximately 1,000°C in flowing air, but that at higher temperatures, the volatility of its oxide limits use of pure iridium. Alloy coatings of iridium with platinum, palladium, and rhodium up to 4 mils thick were formed from a fused sodium cyanide electrolyte; because their oxides are less volatile, these alloys may protect substrates at higher temperatures. Deposits made from aqueous electrolytes either had very low rates of deposition or were highly stressed and cracked when heavy deposits were made. Author

N67-37360# Atomic Energy Commission Research Establishment, Lucas Heights (Australia).

RADIATION CHEMISTRY OF ACETYLENE—A REVIEW

K. G. Mc Laren Feb. 1967 21 p refs

(AAEC/TM373) CFSTI HC $3.00/MF $0.65

The literature on the high energy radiation chemistry of acetylene is reviewed. Radiolysis of pure acetylene produces mainly polymeric products (polyacetylenes) with a radiation yield G ($-C_2H_2$) of about 70. Small quantities of benzene (G (benzene) ≈ 7 to 15) are also formed. Little is known about the polyacetylenes save that they are non-crystalline, insoluble and stable at temperatures up to around 300°C. Discrepancies are found in effects of experimental variables (temperature, pressure, radiation intensity, and the presence of inert gases or radical scavengers) as reported by different workers. Little information is available about radiation-induced reactions of acetylene with other materials such as hydrogen, sulphur dioxide, ammonia, and oxygen. Acetylene-oxygen mixtures have been reported to yield polyacetylenes possessing carbonyl, carboxylic, and other functional groups. These polymers were soluble in polar solvents. Some systems of potential interest for radiation research are discussed. Author

N67-37362# Idaho Nuclear Corp., Idaho Falls.

ANALYTICAL CHEMISTRY BRANCH ANNUAL REPORT FOR 1966

Apr. 1967 160 p refs

(Contract AT(10-1)-1230)

(IN-1063) CFSTI: HC $3.00/MF $0.65

Research progress is reported on: classical methods of analysis, radiochemical methods of analysis, electroanalytical studies, development in support of LOFT program, remotely operated facilities, spectrochemical analysis, mass spectrometers, analytical services, improvements in methods and equipment, and standards and quality control. NSA

N67-37377# Aerospace Corp., El Segundo, Calif. Aerodynamics and Propulsion Research Lab.

REACTIONS OF SULFUR HEXAFLUORIDE WITH EXPLODING METALS

Eileen Cook and Bernard Siegel Jun. 1967 19 p refs

(Contract AF 04(695)-1001)

(TR-1001(2210-10)-4; SSD-TR-67-109; AD-656312)

Sulfur hexafluoride reacts with a number of electrically exploded metals to form sulfur tetrafluoride and a metal fluoride. The extent of reaction and the degree of utilization of the imparted electrical energy are shown to be related to reaction energetics and a physical model of the interactions between exploding metals and a surrounding gas. In each of the reactions that has been studied, reaction occurred only to the extent that the metal participated chemically. There was no self-pyrolysis of SF6 molecules, although sufficient energy had been provided for such pyrolysis to occur. The synthesis of PtF2 from exploding Pt and SF6 indicates that this technique offers promise as a method for preparing the lower fluorides of those transition metals that commonly exhibit a number of valences in their halides. Author (TAB)

N67-37380# York Univ., Toronto (Ontario). Centre for Research in Experimental Space Science.

RESEARCH DIRECTED TOWARDS THE STUDY OF MOLECULAR BAND INTENSITIES AND DERIVED QUANTITIES Final Report, Jan. 15, 1966–Jan. 14, 1967

R. W. Nichols 3 May 1967 20 p refs

(Contract AF 19(628)-5813)

(AFCRL-67-0306; AD-656493)

The results of work in the following areas are summarized: Intensity measurement of molecular spectra; identification atlas of molecular spectra; analysis of molecular spectra; shock tube and laser excitation of powdered solids; molecular potentials and vibration and vibration-rotation wave functions; derived quantities of molecular wavefunctions; study of Honl-London factors; study of atomic and molecular structure. Publications arising from the work are listed. TAB

N67-37392# Ionics, Inc., Cambridge, Mass.

ELECTROCHEMICAL CARBON DIOXIDE SENSOR Final Report, Oct. 1965–Oct. 1966

Frank B. Leitz Wright-Patterson AFB, Ohio, AMRL May 1967 55 p

(Contract AF 33(615)-3261)

(AMRL-TR-66-237; AD-655936)

The purpose of the program was to develop a novel carbon dioxide sensor based on obtaining changes in the electrical resistance of anion-exchange resin proportional to the ambient partial pressure of carbon dioxide. The change in resistance is due to the increased ionization of a weakly ionized base in the presence of a sightly acid gas. A laboratory program was conducted to evaluate the response of various types of weak-base ion-exchange polymers to carbon dioxide concentrations in the range of 0 to 4%. The optimum material consisted of a condensation polymer of resorcinol, formaldehyde and triethylenetetramine. A laboratory model of the CO2 Sensor was fabricated using these sensing elements in the form of small, thin strips. In order to minimize the effects of humidity and temperature, the model contained two sensing elements, one being a reference. A guard chamber was provided to absorb any strongly-acid gases. Electrical readout is made on a balancing potentiometer with an earphone detector. The Sensor is small (about 50 cubic inches), weighs less than 6 ounces, has a power requirement of less than 0.5 watts, and its operation is independent of gravity. Author (TAB)

N67-37401# Iowa State Univ. of Science and Technology, Ames. Ames Lab.

COMPILATION OF RARE-EARTH PRODUCTS AVAILABLE FROM COMMERCIAL SUPPLIERS

Joan E. Smith and K. A. Gschneidner, Jr. Feb. 1967 216 p

(Contract W-7405-ENG-82)

(IS-RIC-1) CFSTI: HC $3.00/MF $0.65

The suppliers of rare earth products, the products, purities, and prices are listed. The data are organized in the following 6 categories: metals, alloys, compounds, mixtures, solutions, and special products. NSA

N67-37414# Bureau of Mines, Albany, Oreg. Metallurgy Research Center.

THERMODYNAMIC DATA FOR CUPROUS AND CUPRIC OXIDES

Alla D. Mah, L. B. Pankratz, W. W. Weller, and E. G. King Sep. 1967 25 p refs

(BM-RI-7026)

Heat content and entropy data at high temperatures were obtained for cuprous oxide (Cu_2O) and cupric oxide (CuO). Experimental results and smooth values are reported. Equations are given for heat content increments and heat capacities above 298°K. Low-temperature heat capacity data were obtained for cuprous oxide. Evaluation of the 298°K entropy gave, $S°_{298.15}(Cu_2O) = 22.08 \pm 0.10$ cal/deg mole. Heat of formation values were determined for cuprous and cupric oxides. The values are: $H°_{298.15}(Cu_2O) = -40,830 \pm 300$ cal/mole, and $H°_{298.15}(CuO) = -37,230 \pm 150$ cal/mole. Heat and free energy of formation data are tabulated for cuprous oxide (298°–1,600°K) and for cupric oxide (298°–1,400°K). Heat, free energy, and equilibrium pressure values are given for the dissociation of cupric oxide (298°–1,400°K). Author

N67-37417# Bureau of Mines, College Park, Md. Metallurgy Research Center.

DEVELOPING A THERMOCHEMICAL MODEL FOR THE IRON BLAST FURNACE. MEASUREMENT OF RATE COEFFICIENT FOR REDUCTION OF IRON ORE PELLETS IN A PACKED BED

Hillary W. St. Clair Oct. 1967 25 p refs

(BM-RI-7031)

The effective coefficient for rate of reduction of a sample of granular iron ore may be determined by passing the reducing gas through a bed of the ore at constant flow rate and periodically analyzing the effluent gas. The method of analyzing the data is based on a mathematical model that takes into account the variation in composition of the gas and solids with time and position in the bed. A method is described for determining the value of the rate coefficient that gives best agreement between the observed and calculated analyses of the effluent gas. Author

N67-37422# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

CHEMICAL THINNING OF PNEUMATICALLY IMPACTED UO_2 FOR ELECTRON TRANSMISSION MICROSCOPY

M. P. Bauleke May 1967 11 p refs

(Contract AT(45-1)-1830)

(BNWL-416) CFSTI: HC $3.00/MF $0.65

Procedures for chemical thinning of UO_{2+x} and resulting electron micrographs of thinned areas are described. Polycrystalline pneumatically impacted UO_{2+x} specimens having O:U ratio ranging between 1.90 and 2.15 were chemically thinned to 100 kV electron transparency. Hypostoichiometric UO_{2-x} was easier to thin than hyperstoichiometric UO_{2+x}; stacking fault dislocations were easily seen in UO_{2+x} but seldom seen in UO_{2+x}. NSA

N67-37432# Los Alamos Scientific Lab., N. Mex.

THE PREPARATION OF OXYGEN-17 ENRICHED WATER FROM ENRICHED NITRIC OXIDE GAS

Daniel Pavone and Mohammed Alei, Jr. 6 Jul. 1967 6 p ref

(Contract W-7405-ENG-36)

(LA-3698) CFSTI: HC $3.00/MF $0.65

A process and equipment designed to produce water enriched in oxygen-17 and oxygen-18 isotopes from correspondingly enriched nitric oxide gas is described. Approximately 1450 ml of high purity enriched water containing 1 to 3% oxygen-17 and 10 to 20% oxygen-18 have been produced for use primarily in nuclear magnetic resonance experimentation. Substantial quantities of nitrogen enriched in nitrogen-15 have been recovered as a by-product. Author (NSA)

N67-37481# California Univ., Berkeley. Lawrence Radiation Lab.

RESPONSE MODE ANALYSIS AND CONTROL OF MULTIVARIABLE CHEMICAL PROCESSES: APPLICATION TO DISTILLATION

Robert Edward Levy (Ph.D. Thesis) Jun. 1967 320 p refs

(Contract W-7405-ENG-48)

(UCRL-17480) CFSTI: HC $3.00/MF $0.65

The natural modes of a multivariable process may serve as the framework for a feedback control scheme that hastens the response of the process, overcomes the problem of control loop interaction, and guides the selection and interconnection of measured and manipulated variables. The independent modes of a simulated binary distillation column were identified, and their significance and physical basis evaluated. This provides information necessary for the development of modal controllers. Distillation modes were determined from three different mathematical models, the most comprehensive of which includes unsteady balances for mass, chemical species, and enthalpy. The accurate computation of modes for the large unsymmetric matriyes generated by the models requires efficient numerical procedures, such as the QR algorithm for eigenvalues and an inverse iteration scheme for eigenvectors. The dominant, or most slowly decaying, mode were associated with compositions throughout the column, but not with enthalpy or mass accumulation. It was highly activated by all inputs to the column. The second slowest mode, which has a characteristic decay time 2.5 times shorter than the slowest, can be identified with the accumulator. The effects of various design and operating conditions on the modes were evaluated. A sensitivity analysis revealed those distillation parameters whose values influence the slow modes most strongly. The limitations of modal control caused by partial observability and partial controllability were examined. A modal controller was developed by approximate methods for the slowest mode of the column. It decreased the process response time by a factor of 2.5 and caused very little alteration of the faster modes. A feedforward controller that detects disturbance inputs and cancels the activations of the three slowest modes was also investigated. The influence of these disturbances can be reduced by an order of magnitude in this way. Author (NSA)

N67-37488# Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.

GEL-ADDITION PROCESS CHEMICAL STUDIES Quarterly Progress Report, Jan.–Mar. 1967

E. C. Moncrief May 1967 39 p refs

(Contract AT(30-1)-3714)

(BAW-3714-3; QPR-3) CFSTI: HC $3.00/MF $0.65

Development of the gel-addition process for preparing plutonia-urania mixed oxide fuels has been extended from a study of the interaction of UO_2 gels and Pu solutions to include development of equipment for firing to oxides and methods for examining oxide microstructure. Improving the uptake of Pu on UO_2 gel spheres, decreasing the attrition and losses of gel spheres, and determining the distribution of Pu in contacted gel and fired oxide spheres are discussed. Notable success was achieved in each of these areas. Pu uptake ranging from 20–23% Pu/U+Pu was obtained in both gel and fired oxide spheres that had been double-contacted with Pu(IV) nitrate solutions. Attrition of UO_2 gel spheres contacted with HNO_3 under inert atmosphere was reduced as low as 1%. Alpha autoradiographs of calcined gel-addition spheres showed uniform distribution of Pu within each sphere, although a slight variation was noted between spheres. Author (NSA)

N67-37571# Argonne National Lab., Ill.
REPROCESSING MIXED OXIDE FUELS BY FLUORINATION
J. Schmets, G. Camozzo, R. Heremans, and G. Pierini Mar. 1967 24 p refs Transl. into of the Paper Presented at the IAEA Colloq. on the Use of Plutonium as a Reactor Fuel, Brussels, 13–17 Mar. 1967
(Contracts EURATOM-006-65-7-RCIB (RD); EURATOM-016-65-1 RAP B)
(ANL-TRANS-478; CONF-670306-6) CFSTI: HC $3.00/MF $0.65

The use of chlorine mono- and trifluorides for reprocessing Zircaloy-clad UO_2–PuO_2 fuels was studied. The multivalent character of the chlorine fluorides, used pure or in a mixture, is discussed. The chief characteristic of ClF_3 is direct attack on the fuel, whereas that of ClF is selective with respect to U. NSA

N67-37617# Mound Lab., Miamisburg, Ohio.
MOUND LABORATORY Quarterly Progress Report, Jul.–Sep. 1966
28 Apr. 1967 35 p refs
(Contract AFT(33-1)-GEN-53)
(MLM-1388) CFSTI: HC $3.00/MF $0.65

The half lives of ^{211}Pb and ^{210}Po were determined using the decaying pair method, and neutron yields from the reaction $^{19}F(\alpha,n)^{22}Na$ on thick targets were measured. High-purity ^{234}U was separated from aged ^{238}Pu using an anion exchange—hexone extration–anion exchange method, and it was determined that ^{229}Th could be separated from aged ^{233}U by solvent extration using di–sec–butyl phenyl phosphonate in diethyl benzene. A live–timer system that permits the direct determination of the resolving time of a proportional counter was developed, and the reduction of data in the measurement of fast neutron spectra using stilbene—crystal spectrometers was studied. A method for determining boron and boron isotopes using neutron activation was also developed, and electron inductive effects in substituded polystyrenes were investigated by NMR spectroscopy. NSA

N67-37638 Joint Publications Research Service, Washington, D. C.
COMMUNIST CHINESE SCIENTIFIC ABSTRACTS—CHEMISTRY, NUMBER 85
7 Sep. 1967 33 p refs
(JPRS-42500; TT-67-33128) CFSTI: $3.00

Abstracts are presented on articles which appeared in the Communist Chinese Chemistry Bulletin editions of January, February, and August 1960. The author's name and affiliation—usually a university, high school, or research institute—are given. M.G.J.

N67-37639# Rocky Flats Div., Dow Chemical Co., Golden, Colo.
LOW TEMPERATURE ADSORPTION OF OXYGEN ON SINTERED PLUTONIUM DIOXIDE
J. L. Stakebake and M. R. Dringman 19 Jun. 1967 9 p refs
(Contract AT(29-1)-1106)
(RFP-915) CFSTI: HC $3.00/MF $0.65

The effect of 800°C sintering on the plutonium dioxide surface and its subsequent oxygen adsorption was investigated. The results of adsorption measurements along with a proposed adsorption mechanism are discussed. These results are compared with those obtained for the original low-temperature plutonium dioxide. Author (NSA)

N67-37667# Tyco Labs., Inc., Waltham, Mass.
RESEARCH ON THE ELECTROCHEMICAL OXIDATION OF HEXANE AND ITS ISOMERS Semiannual Interim Report No. 3, Nov. 16, 1966–May 15, 1967
S. B. Brummer, A. H. Taylor, and M. J. Turner 15 May 1967 80 p refs
(Contract DA-44-009-AMC-1408(T))
(AD-656472)

The electrochemical reactions of CH4, C3H8, n-C8H14, and CO2 on platinum electrodes in 80% H3PO4 at 130C were investigated. Experimental studies of steady state kinetics, steady state adsorbate coverage on smooth and platinized Pt, and the kinetics of oxidation of the adsorbed layers have been made. Steady state coverage with C3H8, n-C6H14, and reduced CO2 is lower on platinized Pt than it is on smooth Pt. C3H8 coverage is much more pressure sensitive on platinized Pt. When CH4 is adsorbed on smooth Pt, it appears to break down rapidly to form O-type. This indicates the high reactivity of C1 radicals compared with O-type. Little or no CH-alpha is formed. At low potentials (< or = 0.30 v vs. RHE) the rate of C3H8 oxidation decreases with increase in pressure. Studies of the reactions of the O-type adsorbate with C3H8 on platinized Pt allow the tentative assignment of 8-10 electrons for each 3 carbon atoms for the step O-type to CO2. TAB

N67-37670# Harry Diamond Labs., Washington, D. C.
INFLUENCE OF CHARGE COMPENSATION ON UV-EXCITATION OF RARE-EARTH FLUORESCENCE
Walter Viehmann May 1967 28 p refs
(HDL-TR-1350; AD-656599)

Excitation spectra for the fluorescence transitions of Tb(3+), Eu(3+), and Dy(3+) were obtained at room temperature on single crystals of the tungstates and molybdates of Ca, Sr, Pb, and Cd, having the Scheelite structure, and on terbium-doped crystals of CaF2 and SrF2. Rare-earth concentrations were nominally one atomic percent and charge compensation was provided by vacancy formation or interstitials, by substitution in cation-sites or by anionic substitutions. Strong UV-excitation bands were found for Tb- and Eu-doped crystals and weaker bands for Dy-doped matrices. The bands generally occur near the host-lattice absorption-edge but their intensities and energy positions are strongly influenced by the charge-compensating defects near the active ion. The long wavelength peaks of the bands occur at energies coinciding with 4f-level positions of the rare-earth ions, suggesting a strong perturbation of 4f-levels by charge transfer states. The short-wavelength regions of the excitation bands are ascribed to exchange transfer from UV-absorbing groups. Author (TAB)

N67-37671# Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.
THERMISTORIZED EBULLIOMETRY SYSTEM FOR DETERMINING MOLECULAR WEIGHTS OF FLUOROCARBONS
R. D. Rivers, W. O. Gentry, and C. A. Kienberger 17 Jul. 1967 21 p refs
(Contract W-7045-ENG-26)
(K-1690) CFSTI: HC $3.00/MF $0.65

A thermistorized ebulliometry system was devised, constructed, and calibrated for making molecular weight measurements of fluorocarbon compounds, using Freon-113 as the solvent. The system consisted of a glass probe containing thermistors encased in epoxy resin, a commercially fabricated vacuum-jacketed ebulliometer, a bridge circuit, and an electronic galvanometer. The ebulliometry system was thermally insulated with plastic foam and shielded with an electrically grounded aluminum case. The thermal noise

background of the new system limited the temperature readability to ±0.00035°C, approximately one-tenth that of a former thermometer ebulliometry system. This decrease in noise background, when applied to molecular weight measurements, represents a corresponding improvement in precision of about tenfold over previous molecular weight measurements in the range of 1000 to 1200. The absolute standard deviation of a single molecular weight measurement in this range is ±8 mol. wt units for the new system. Author (NSA)

N67-37672* Pennsylvania Univ., Philadelphia. Electrochemistry Lab.
STUDIES IN FUNDAMENTAL CHEMISTRY OF FUEL CELL REACTIONS Semiannual Progress Report, 1 Jan.–30 Jun. 1967
30 Jun. 1967 81 p refs
(Grant NsG-325)
(NASA-CR-88634; Rept.-10) CSCL 07D

The status of the following studies is summarized: (1) mechanism of porous electrodes, including the finite contact angle meniscus and the thin film meniscus for obtaining high current densities, the heating effects, and computer calculations of electrode behavior; (2) mechanism of electrocatalysis, which centers on the atom transfer mechanism and the Fe^{3+}/Fe^{2+} redox reaction; (3) potential of zero charge determination involving platinum and a method based on the fact that friction between two surfaces is a function of potential; (4) adsorption of organics on metal surfaces using the potentiostatic method and benzene adsorption; (5) formation mechanism and growth rate of zinc dendrites, and dendritic zinc formation in a small cell where the electrodes undergo regular continual charge–discharge processes; and (6) reversibility of organic reactions to find a system most promising for use in secondary batteries in which such compounds as ethyl sulfide, Et_2S, ethyl sulfone, Et_2SO_2, tetramethylene sulfide, sulfoxide and sulfone, cylohexane hexone, C_6O_6, and its relative benzenehexol, $C_6(OH)_6$ were investigated. A list of pertinent publications generated during the period 1964–1967 is included. K.W.

N67-37676# Bureau of Mines, Rolla, Mo.
MAGNETIC SUSCEPTIBILITY OF 19 NICKEL- AND COBALT-BEARING MINERALS
H. E. Powell Oct. 1967 14 p refs
(BM-IC-8351)

Magnetic susceptibilities were determined for 19 cobalt- and NICKEL-bearing minerals and for a suite for synthetic cobalt-nickel diarsenides analogous to the rammelsbergite and safflorite series. Relations between susceptibility and composition were found to be nonlinear for both impure natural minerals and pure synthetics. Author

N67-37677*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SYNTHESIS OF ULTRAHIGH MOLECULAR WEIGHT POLY(ETHYLENE TEREPHTHALATE)
Li-chen Hsu Washington, NASA, 1967 21 p refs Presented at the Cryogenic Polymers Conf., Cleveland, 25–27 Apr. 1967; sponsored by NASA and Case Inst. of Tech.
(NASA-TM-X-52349) CFSTI: HC $3.00/MF $0.65 CSCL 11I

Poly(ethylene terephthalate) of number average molecular weight of the order of 120,000 was prepared from commercial grade material in the solid state with a gas chromatograph apparatus. Parameters studied were the catalyst, particle size, the molecular weight of the starting material, the reaction temperature and time, and the nature and flow rate of the carrier gas. Author

N67-37689# California Univ., Berkeley. Lawrence Radiation Lab.
POLARIZATION OF INDIUM NUCLEI IN FERROMAGNETS AND NUCLEAR MAGNETIC RESONANCE OF POLARIZED COBALT IN IRON
Rondel James Holliday (M.S. Thesis) May 1967 47 p refs
(Contract W-7405-ENG-48)
(UCRL-17536) CFSTI: HC $3.00/MF $0.65

The hyperfine magnetic fields at In nuclei dissolved in iron and nickel were determined by low-temperature nuclear orientation of ^{114m}In in iron and nickel. ^{57}Co was used as the thermometer. The results are: H_{int}(In in Fe) = −295±10 kG. H_{int}(In in Ni) = 42±6 kG. Nuclear magnetic resonance was observed in ^{60}Co nuclei polarized in iron at low temperatures. The resonance frequency is 165.75±0.15 MHz. Author (NSA)

N67-37726# Dartmouth Coll., Hanover, N. H. Thayer School of Engineering.
IRON AND IRON–CHROMIUM ALLOY SILICA REACTION STUDIES Interim Report, Dec. 1, 1965–Nov. 30, 1966
D. R. Muzyka and G. A. Colligan Watertown, Mass., Army Mater. Res. Agency, Nov. 1966 143 p refs
(Contract DA-19-020-AMC-00508(X))
(AMRA-CR-67-07/1; AD-655584)

This investigation is concerned with the chemical reactions that occur when iron and iron-chromium alloys, which are the basis for high strength steels, are held in contact with silica. The results show that the addition of chromium to the equilibrium system Fe-Si-C-O causes additional condensed phases to occur. Under reducing conditions, the phase iron-chromium spinel with composition between magnetite (FeO.Fe2O3) and chromite (FeO.Cr2O3) occurs. High Temperatures, 1550 and 1600C, led to the stability of silicate liquid at reducing conditions due to the melting of the spinel phase. This effect lowers the oxidation potential necessary to completely inhibit metal-silica interaction in the presence of chromium compared to pure iron. The general mechanism of metal transport across the mold-metal interface in silica refractory during the casting process is shown to involve liquid metal oxide formation, penetration and solution of the silica, precipitation of solid, complex oxides and finally the reduction of a portion of this oxide to metal. The beneficial effect of chromium in slowing these reactions is the promotion of solid phase formation, increased viscosity of the silicate liquid, decreased solution rate of silica and decreased rate of supply of catalyst ions to the primary reaction interface. TAB

N67-37778# Berg (T. G. Owe), Inc., Santa Ana, Calif.
INVESTIGATION OF THE KINETICS OF CONDENSATION Final Report, 1 Jul. 1966–30 Jun. 1967
T. G. Owe Berg, Gene E. Carpenter, Joyce E. Clutter, and D. C. George Ft. Monmouth, N. J., Army Electron. Command, Jul. 1967 23 p refs
(Contract DAAB07-67-C-0080)
(ECOM-0080-F; AD-655496)

Nucleation of condensation in an expansion chamber using NH4Cl particulate has been studied. The NH4Cl particulate was prepared by mixing gaseous NH3 and HCl, both at a concentration of 20ppm in pure (bottled) air. When laboratory air was carefully excluded from the system, the NH4Cl formed no detectable cloud before or after expansion. When a trace of NO, less than 10ppm in N2, was added to the NH4Cl there was no cloud before the expansion but a dense cloud after expansion. It is concluded that the condensation occurs by a chain reaction type mechanism, in which the NO serves as the chain initiator and the NH4Cl particulate serves to stabilize droplets that are too small to be stable alone. The initiator gas in ordinary air remains to be identified. It was found that NO may be removed from air by adsorption in an aerosol filter. Author (TAB)

N67-37800 Joint Publications Research Service, Washington, D. C.

THERMAL DECOMPOSITION OF URANIUM OXIDES IN A VACUUM

I. I. Kozhina, L. V. Shiryayeva, and Yu. M. Tolmachev 12 Sep. 1967 15 p refs Transl. into ENGLISH from Vestn. Leningr. Univ. (Leningrad), no. 10, May 1967 p 133–140
(JPRS-42561; TT-67-33189) CFSTI: $3.00

The dissociation of U_3O_8 in a vacuum (10^{-4} to 10^{-5} mm Hg) was investigated in the temperature range 300° to 900°C. The oxides of various compositions were subjected to chemical and X-ray analyses to establish phase ratios. The rhombic phase resulting from the decomposition is established to be in the composition range of $UO_{2.662}$ to $UO_{2.605}$. A fluorite phase was also found with a lesser oxygen index. C.T.C.

N67-37813# Soreq Research Establishment, Israel Atomic Energy Commission, Yavneh.

A COMPILATION OF SPECIFIC BIMOLECULAR RATE CONSTANTS FOR THE REACTIONS OF HYDRATED ELECTRONS, HYDROGEN ATOMS, AND HYDROXYL RADICALS WITH INORGANIC AND ORGANIC COMPOUNDS IN AQUEOUS SOLUTION

M. Anbar and P. Neta Feb. 1966 52 p refs
(IA-1079)

The specific rate constants of reactions of hydrated electrons were determined for over 500 compounds and are presented in tables. Reactions of hydrogen atoms and hydroxyl radicals were also studied and the data tabulated. NSA

N67-37838# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Materials Lab.

EVALUATION OF MOLECULAR WEIGHT FROM EQUILIBRIUM SEDIMENTATION. PART I: COMPUTATION BASED ON EXPERIMENTAL SCHLIEREN PLOT Technical Report, Jan. 1966–Feb. 1967

Matatiahu Gehatia Jun. 1967 19 p refs
(AFML-TR-67-121, Pt. I; AD-655352)

A new method has been developed to determine molecular weight (specifically, ratio g = s(omega sq.)/D, where omega = angular velocity, s = sedimentation coefficient, D = diffusion coefficient) from an experimental schlieren plot, dc/dr vs r, taken at equilibrium. By applying this method, one can determine the entire distribution of molecular weight from equilibrium sedimentation, as well as the average values. TAB

N67-37849# Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.

THE STRUCTURE OF THE M'-PHASE OF $YTaO_4$, A THIRD FERGUSONITE POLYMORPH

Gerard M. Wolten Feb. 1967 25 p refs
(Contract AF 04(695)-1001)
(TR-1001(2250-10)-5; SSD-TR-67-66; AD-656335)

The M'-phase of fergusonite is closely related to the other known monoclinic form (M-phase), except that it has a halved b-axis and its space group is P2/a instead of I2. The structure of the M'-phase was determined for YTaO4 from three-dimensional diffractometer data, and its relationship to the other polymorphs is discussed. The lattice parameters of M'-YTaO are: a = 5.292A, b = 5.451A, c = 5.110A, beta = 96.44 deg., Z = 2. Author (TAB)

N67-37862# Army Weapons Command, Rock Island, Ill. Research & Engineering Div.

SYNTHESIS OF CARBORANE MODIFIED FLUOROCARBON ELASTOMERS

Lynn G. Wiedenmann Jun. 1967 24 p refs
(RIA-67-1422; AD-656455)

C-isopropyl-c-bromotrifluorovinylcarborane was synthesized. This did not polymerize with peroxide catalyst. The use of vinyl- or allylcarborane in peroxide initiated emulsion systems with commercial fluorocarbon monomers inhibited all polymerization except for one isolated case of a vinylidene fluoride-vinylcarborane resin. Here a copolymer was apparently formed. With Cobalt Co60 initiation, fluorocarbon polymer (TFE) was formed in the presence of allylcarborane. A mechanical mixture of a carborane and a fluorocarbon elastomer caused a decrease in the decomposition temperature, as evidenced by Differential Thermal Analysis. Author (TAB)

N67-37853# Oak Ridge National Lab., Tenn. Isotopes Development Center.

ELECTROMAGNETIC SEPARATION AND CHEMICAL REFINEMENT OF CERIUM ISOTOPES

W. K. Henderson, W. A. Bell, C. R. Croft, C. W. Sheridan, A. M. Veach, et al Jul. 1967 25 p refs
(Contract W-7405-ENG-26)
(ORNL-4127) CFSTI: HC $3.00/MF $0.65

The electromagnetic separation of cerium isotopes provided >1100 g of recovered isotopes with an isotopic purity of 35.38% for ^{136}Ce, 14.32% for ^{138}Ce, 99.70% for ^{140}Ce, and 92.77% for ^{142}Ce (natural abundance percentages —0.193, 0.250, 88.48 and 11.07 respectively). The quantities and isotopic purities of the cerium isotopes collected were greater than those for any other cerium separation series. A special two-piece pocket designed to minimize contamination was used for the collection of ^{136}Ce of higher isotopic purity. Liners used on experimental runs for high-purity collections had the 5-in. spaced, full length, carbon side shields and were baffled to pass ions through a +1°, −5° opening in the 90° position. Various combinations of charge materials, support gases, and activation-suppressing materials were tried in a search for stable operations. Low-fired cerium (IV) oxide [prepared by firing cerium (III) oxalate at 600°C] chlorinated internally by CCl_4 was the preferred charge material over previously prepared $CeCl_3$. Helium was a more satisfactory support gas than nitrogen, and argon was the most satisfactory of those used. Carbon disulfide used as a support gas suppressed filament activation better than argon, but its prolonged use caused detrimental deposits of carbon in the arc chamber. Author (NSA)

N67-37891# Oak Ridge National Lab., Tenn.

DIELECTRIC CONSTANTS AND REFRACTIVE INDICES OF SOLUTIONS OF SOME ORGANOPHOSPHORUS COMPOUNDS IN N-OCTANE

W. J. McDowell 13 Jun. 1967 5 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1893) CFSTI: HC $3.00/MF $0.65

Dielectric constant and refractive index data are presented for n-octane solutions of several high molecular weight organophosphorus compounds used in solvent extraction systems. Dielectric constant data are included for di(2-ethylhexyl)phosphoric acid (HDEHP), its sodium and strontium salts (and complexes of these salts with additional acid), for tri-n-butylphosphate (TBP), tri-n-octyl-phosphine oxide (TOPO), and mixtures of these neutral organophosphorus compounds with HDEHP, its salts and complexes. Refractive indexes of HDEHP, TBP, $Sr(DEHP)_2$, NaDEHP 3 HDEHP, and TOPO solutions are included. Author (NSA)

N67-37892# Oak Ridge National Lab., Tenn.
ELECTROMAGNETIC SEPARATION AND CHEMICAL REFINEMENT OF LEAD ISOTOPES, SERIES LU
L. L. Jordan, J. A. Kinnane, C. W. Sheridan, J. G. Tracy, and L. O. Love Jul. 1967 25 p
(Contract W-7405-ENG-26)
(ORNL-4107) CFSTI: HC $3.00/MF $0.65

Lead isotopes were separated and refined to provide an isotopic purity of >73% for ^{204}Pb and >92% for ^{207}Pb. The average total ion output reaching the collector during the series was 21.0 ma and the percent of innage, 89.4. Best results were achieved by the use of a standard $PbCl_2$-charged M-18 ion source unit utilizing a 1/8- × 4-in. ion exit slit, an ion collector with a probe pocket, and a liner with a +10° to −4° ion-exit-angle baffle in the 90° position with additional side shields ahead of the 90° position. Operating procedures were developed to compensate for several characteristics associated with the enrichment of lead in the calutron. These characteristics included defocusing of the ion beam, slowly deteriorating focus and subsequent decrease in monitored ion current, and sparking and defocusing tendencies appearing in the latter stages of a run as a result of lead deposits on the negative electrode. Author (NSA)

N67-37908# DuPont de Nemours (E. I.) and Co., Wilmington, Del. Freon Products Div.
FREON C-51-12 FLUOROCARBON—A NEW, INERT, VOLATIVE LIQUID
1967 15 p refs *Its* Freon Tech. Bull.
(EL-13)

Characteristics and properties are reported for Freon C-51-12, a mixture of perfluorodimethylcyclobutane isomers with the 1,2-isomers predominating. This inert liquid is chemically and thermally stable up to at least 500°F and is compatible with plastics, elastomers, and coatings. Essentially hazard-free, it is noninflammable and has a low order of toxicity. It is ideal for evaporative cooling, has high dielectric strength and resistivity; and is colorless, clear, and stable through visible and ultraviolet as low as 2000 Å. Some of these properties are tabulated; and the effects of Freon C-51-12 are tabulated for a wide variety of elastomers, plastics, and magnet wire coatings. Its liquid density, heat capacity, viscosity, and thermal conductivity are graphed. M.W.R.

N67-37916# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
ULTRAHIGH VACUUM TECHNIQUES Final Report, 1 Jun.–30 Nov. 1966
R. Fraulenfelder, W. J. Lange, and J. H. Singleton 4 May 1967 38 p refs
(Contract AT(30-1)-2823)
(WERL-2823-26) CFSTI: HC $3.00/MF $0.65

Two experimental studies are presented: hydrogen permeation in tungsten, and the replacement of one absorbed gas by a second from a gas phase. The permeation, solubility, and diffusion constants are being determined directly and independently of one another for the first time for hydrogen permeation through tungsten. In addition to the H_2–W system some measurements have been made on the N_2–W and N_2–Mo systems as a check on both the method and for comparison with literature values. In the study of replacement of an adsorbed gas, no measurable replacement has been observed for the H_2–N_2 system on tungsten. NSA

N67-37926# Sundstrand Corp., Rockford, Ill. Aviation Div.
ORGANIC RANKINE CYCLE TECHNOLOGY PROGRAM Quarterly Progress Report, 1 Jan.–1 Apr. 1967
A. Warren Adam 14 Apr. 1967 44 p refs
(Contract AT(04-3)-651)
(SAN-651-25; QPR-4) CFSTI: HC $3.00/MF $0.65

The investigation of the pyrolytic degradation of biphenyl and the eutectic mixture of biphenyl and biphenyl ether was continued. Design and fabrication of four sealed test loops for this work is virtually complete. A feasibility study is in progress to determine suitable methods of joining silicon to stainless steel with a hermetic seal. Distillation apparatus for the working fluid, which may be operated at either atmospheric pressure or vacuum, has been constructed. Bearing test rig and test loop designs are finalized and are being drafted. Analytical design of a full admission centrifugal pump has been completed. A jet pump test fixture and loop have also been designed. Qualitative evaluation of the relative wetting capabilities of biphenyl and biphenyl–biphenyl ether eutectic on several metals is complete. Wetting characteristics are nearly all similar except that the eutectic was slightly better with 347 stainless steel and 2024 Al. Preliminary designs of the Boiler Test Loop have been completed and submitted. NSA

N67-37928# Los Alamos Scientific Lab., N. Mex.
AN EVALUATION OF THE HEAT OF VAPORIZATION OF URANIUM FROM THE BEHAVIOR OF THE U-C SYSTEM
Edmund Storms 1967 16 p refs Presented at Intern. Symp. on Temp. Chem., Argonne, Ill.
(Contract W-7405-ENG-36)
(LA-DC-8790; CONF-670527-1) CFSTI: HC $3.00/MF $0.65

The heat of vaporization behavior of pure U has not been deduced by direct measurements. An evaluation of the heat of vaporization of U from the behavior of the U–C system is given. Some direct vapor pressure measurements have been made in the U–C system. NSA

N67-37933# Cologne Univ. (West Germany).
MEAN LIFE TIME MEASUREMENTS OF THE GROWING CHAIN FOR RADIATION INDUCED POLYMERIZATION IN DISPERSED SYSTEMS [STRAHLENCHEMISCHE INITIIERUNG BEI DER BESTIMMUNG DER MITTLEREN LEBENSDAUER DER WACHSENDEN KETTE IN DISPERSEN POLYMERISATIONSSYSTEMEN]
Christel Schneider and G. Ley Mar. 1967 12 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-21)

Intermittent ^{60}Co γ irradiation was used to determine the mean life-time of growing chains in emulsion polymerization. Values of the mean life-time of radicals and of the termination rate constant of eight vinyl monomers and chloroprene are given. For the styrene system the influence of conversion, emulsifier concentration, and temperature were examined. It was concluded that the observed termination reaction must proceed via an exchange of radicals between different monomer–polymer particles, which hitherto have been considered to be completely isolated. Author (NSA)

N67-37942# Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu.
SORPTION OF RADIORUTHENIUM IN COLLOIDAL AND IONIC STATE ON FERROUS HYDROXIDE FORMED BY ELECTRODISSOLUTION OF IRON ANODE
F. Kepak and J. Kanka Feb. 1967 21 p refs
(UJV-1733)

Ruthenium(III) and nitrosylruthenium(II) both in the ionic and colloidal state, were sorbed with high efficiency on ferrous

hydroxide prepared by electrodissolution of iron anode. In comparison with one-stage precipitation, higher sorption effect was reached when multistage precipitation was used. Prolongation of the sorbent-precipitation time favorably affected the efficiency of sorption. The hydroxide prepared by electrodissolution of iron anode was more effective than that prepared in the usual way. Author (NSA)

N67-37961# Michigan State Univ., East Lansing. Chemistry Dept.
THE EFFECTS OF POLYFUNCTIONAL ANIONS ON ELECTRON TRANSFER BETWEEN METAL IONS IN SOLUTION Progress Report, 1966–1967
Charles H. Brubaker, Jr. 15 May 1967 10 p refs
(Contract AT(11-1)-1001)
(COO-1001-14) CFSTI: HC $3.00/MF $0.65

Developments are reported for studies on oxidation-reduction reactions involving tris(1,10-phenanthroline)iron(II) and related compounds as reducing agents for thallium(III) and peroxydisulfate ions and on the nature and mechanisms of formation and decomposition of molecular oxygen carriers. Preliminary results are also reported for studies on the photochemical acceleration of the electron exchange reaction between U(IV) and uranyl ions. NSA

N67-37962# Wayne State Univ., Detroit, Mich. Chemistry Dept.
CONTROLLED POLYMERIZATION OF ADSORBED MONOLAYERS
H. K. Livingston 15 Dec. 1966 15 p
(Contract AT(11-1)-1580)
(COO-1580-1) CFSTI: HC $3.00/MF $0.65

Research showed that orientation of physically adsorbed molecules can be determined and physically adsorbed layers at near monolayer concentration can be polymerized. The close packing of nitrogen in physical adsorption on a solid surface was compared with that of benzene and furan. The radioinduced polymerization of adsorbed acrylamide and of furan adsorbed on Graphon is described. NSA

N67-37970# Isochem, Inc., Richland, Wash.
THE EVALUATION OF A LOCK-IN AMPLIFIER FOR USE WITH SINGLE-BEAM ATOMIC ABSORPTION SYSTEMS. THE ANALYSIS OF CALCIUM, MAGNESIUM, PALLADIUM, RHODIUM, AND STRONTIUM
D. P. Sandoz 1 May 1967 31 p refs Presented at the Northwest Regional Meeting of the Am. Chem. Soc., Richland, Wash.
(Contract AT(45-1)-1851)
(ISO-SA-37; CONF-670620-2) CFSTI: HC $3.00/MF $0.65

The evaluation of a lock-in amplifier for use with an atomic absorption spectrophotometer was completed. The high signal to noise ratio of this amplifier allowed expansion of the recorder scale resulting in an increase in sensitivity by a factor of 10 for many elements analyzed by atomic absorption spectroscopy. The development of analytical procedures for determination of palladium and rhodium with an atomic absorption spectrophotometer was completed. This analytical method can be used to determine palladium and rhodium in Purex waste solutions. 10% Aliquat-336 dissolved in CCl_4, 4M NH_4SCN–1.5M NH_4OH, 4M NH_4NO_3, 1.5M NH_4OH, 5M $NaNO_3$, CH_3OH, and water. Sensitivities for these two elements in the above solutions varied from 0.3 to 2.5 ug/ml, depending on the solution matrix. Analytical procedures were also developed for determination of calcium, magnesium, and strontium in process essential materials with the atomic absorption spectrophotometer. Sensitivities for these three elements ranged from 0.5 to 3, 0.07 to 0.4, and 0.04 to 4 ug/ml, respectively, depending on the solution matrix and instrumentation. Author (NSA)

N67-37978# California Univ., Los Angeles. Dept. of Chemistry.
FLUOROCARBON SOLUTIONS Final Report
Robert L. Scott Feb. 1967 14 p refs
(Contract AT(11-1)-34)
(UCLA-34P13-22) CFSTI: HC $3.00/MF $0.65

Vapor pressures of fluorocarbon solutions at low temperature, liquid–liquid phase diagrams, heats of mixing, volume changes on mixing, solubility of solids, second virial coefficients, lower critical solution temperatures, gas chromatography, effects of centrifugal fields on liquid miscibility, hydrogen bonding, and theoretical and interpretative studies are discussed. NSA

N67-37989# California Univ., Livermore. Lawrence Radiation Lab.
THERMOCHEMICAL SEPARATION AND SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN RHENIUM
J. R. Stevens and W. F. Morris 10 May 1967 10 p refs
(Contract W-7405-ENG-48)
(UCID-15153) CFSTI: HC $3.00/MF $0.65

A method that is capable of detecting individual impurities in Re to less than 0.1 ppM is described. It combines thermochemical separation of volatile rhenium oxide and spectrographic determination of the residual impurities in a suitable collector. Detection limits for 26 elements are given. NSA

N67-37995# Columbia Univ., New York. School of Engineering and Applied Science.
GRAFT POLYMERIZATION OF COMONOMERS
Robert L. Kruse (Ph.D. Thesis) 1967 115 p refs Supported by AFC, Shell Oil, Continental Can Co., and AROD
(TID-23839) CFSTI: HC $3.00/MF $0.65

The radioinduced grafting of acrylonitrile–styrene to polyethylene was used to test theoretical equations derived for diffusion-controlled grafting of polymer films. The equations were found to be useful for describing the effects of film thickness and radiation intensity in the polyethylene–styrene–acrylonitrile system. The theoretical equations describe the quantitative effects of diffusion on the grafting reaction in terms of the change from volumetric to surface grafting reaction in terms of the change from volumetric to surface grafting, the L_{cv} and L_{cs} values, and the shift of the order of dependence of R_p on R_i. Studies were also made on the copolymer composition of grafted side chains. Mixtures of butadiene–acrylonitrile, styrene–acrylonitrile, styrene–4-vinylpyridine, and styrene–methyl acrylate were grafted to poly(vinyl alcohol) and cellulose, poly(vinyl chloride), polytetrafluoroethylene, and polyethylene by gamma irradiation. From the results it was concluded that graft and nongraft copolymer compositions are in fact identical within the accuracy of infrared measurements. NSA

N67-37998# Northwestern Univ., Evanston, Ill. Chemistry Dept.
THE RADIATION CHEMISTRY OF HIGH POLYMERS Technical Report, Apr. 1, 1966–Apr. 1, 1967
Malcolm Dole 1 May 1967 19 p refs
(Contract AT(11-1)-1088)
(COO-1088-27; TR-12) CFSTI: HC $3.00/MF $0.65

Developments are reported for studies on: development of combined uv and ir cell for absorption spectra measurements at liquid nitrogen temperature; ir spectra of irradiated polyethylene at liquid nitrogen temperature; temperature coefficient of cross-linking, double bond formation, and hydrogen gas evolution in ir-radiated polyethylene; theory of gel crosslink relations and computer solution of the resulting equations; and radiation chemistry of polypropylene oxide. NSA

N67-38015# Argonne National Lab., Ill.
SPARK CHAMBER FILLED WITH NEON TOGETHER WITH ADMIXTURES OF ETHANOL AND WATER VAPORS [ISKROVAYA KAMERA NAPOLNENNAYA NEONOM S DOBAVKAMI PAROV SPIRTA I VODY]
A. D. Vinogradov, N. G. Vlasov, L. P. Kotenko, and G. I. Merzon Jan. 1967 14 p refs Transl. into ENGLISH from the Russian Rept., 13 Oct. 1966 9 p
(ANL-TRANS-426) CFSTI: HC $3.00/MF $0.65

The effect of admixtures of ethanol and water upon the dispersion and width of charged particle tracks was studied in a spark chamber for great delays in the feeding of the high voltage pulse τ_3=2.8–50 microsec. It was found that for all τ_3-values the mean square scattering of the points of tracks is smaller approx. by 5 times in a chamber filled with Ne+C_2H_5OH than in a chamber filled with pure Ne. The dispersion of tracks in the spark chamber filled with Ne+C_2H_5OH corresponds at τ_3=0.5 microsec. The quality of tracks in the spark chamber filled with Ne+H_2O is somewhat worse than for a chamber filled with Ne+C_2H_5OH and considerably better than in pure Ne.
Author (NSA)

N67-38025# Oak Ridge National Lab., Tenn.
DETERMINATION OF OXYGEN AND HYDROGEN IN SODIUM
V. I. Subbotin, F. A. Kozlov, E. K. Kuznetzov, and N. N. Ivanouskii [1966] 25 p refs Transl. into ENGLISH from the Russian Paper Presented at the IAEA Symp. on Alkali Coolants, Corrosion Studies and System Operating Experience, Vienna, 29 Nov.–2 Dec. 1966
(ORNL-TR-1612; CONF-661110-34) CFSTI: HC $3.00/MF $0.65

The vacuum-distillation method was used to determine the oxygen concentration in sodium. The parameters of this method, based on theoretical considerations and experiments, showed a good reproducibility and comparatively small error. The method permits the determination of an oxygen concentration in sodium of the order to (2 to 5) $\times$ 10^{-4} wt %. The hydrogen diffusion indicator was used to determine the hydrogen in sodium. It appeared to be the most sensitive and selective method that permits the tests to be performed directly in the operating plant. The sensitivity of this method amounts to (1 to 2) $\times$ 10^{-4} wt %. The optimum working parameters for the sample indicator were determined and its usefulness for the determination of oxygen, hydrogen, and of the reaction products of sodium with water were examined.
NSA

07 COMMUNICATIONS

Includes communications equipment and techniques, noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N67-36687# Naval Academy, Annapolis, Md. Dept. of Engineering.
AERODYNAMIC BEHAVIOR OF HYPERBOLOIDAL ANTENNA STRUCTURES
Charles O. Heller and William F. Peters, Jr. Jun. 1967 25 p refs
(E-67-5; AD-655832)

The results of a wind-tunnel investigation of the aerodynamic behavior of hyperboloidal antenna structures are presented. Due to the increasing use of such dishes in Cassegrain antenna systems, the information should provide a useful tool for designers of antennas. The study also reveals a close correlation between the behaviors of hyperboloids and paraboloids of equal depth-to-diameter ratios, which indicates that the vast amount of available data concerning the effect of wind on parabolic shells can be used, with confidence, to design hyperbolic shells. An extensive bibliography, which includes publications in the areas of wind profiles and distributions, wind-tunnel experimentation, and the structural behavior of shallow shells, is also included.
Author (TAB)

N67-36690*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
ORBITAL OPERATIONS AND ANALYSIS FOR A 15-MICRON HORIZON RADIANCE MEASUREMENT EXPERIMENT. HORIZON DEFINITION STUDY
William F. Vogelzang, James J. Baltes, and David K. Scharmack May 1967 270 p refs
(Contract NAS1-6010)
(NASA-CR-66376) CSCL 17B

The orbital operations and analysis consisted of the evaluation of orbit and orbit-related parameters, an evaluation of accuracy of spacecraft position determination, a preliminary tracking and data acquisition plan, and the conceptional design of an attitude determination system. A nominally circular, 500-km altitude, sun-synchronous orbit (97.38°) with initial ascending node at 3:00 p.m. local time, and launch date of 28 October meets the experiment and system requirements for the mission. The Western Test Range and a 2-stage improved Delta vehicle should be used to achieve adequate injection accuracy. The S-band range/range-rate system should be used to obtain the raw tracking data. The vhf STADAN telemetry command links should be used as primary links. The range and range-rate S-band system is recommended as a back-up link. The tone-digital command system is recommended. A starmapper and attitude determination concept was developed capable of determining the pointing direction of the spacecraft radiometer to an accuracy of 0.25 km in tangent height at the earth's horizon.
Author

N67-36693*# Scientific Translation Service, La Canada, Calif.
TELEMETRY OF SATELLITES BY LASER AND ITS GEODESIC APPLICATIONS [LA TELEMETRIE DE SATELLITES PAR LASER ET SES APPLICATIONS GEODESIQUES]
R. Bivas Washington, NASA, Aug. 1967 13 p refs Transl. into ENGLISH from Rept. No. 121 of Centre Natl. de la Rech. Sci., Serv. d'Aeronomie (Verrieres-le-Buisson), May 1967 21 p Presented at the Intern. Meeting on Dyn. Methods of Geodesy by Means of Satellites, Paris, 22–25 May 1967
(Contract NASw-1496)
(NASA-TT-F-11192; Rept.-121) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The equipment installed in French and Greek satellite laser tracking stations is described. Results of experiments with the D1-C and D1-D satellites are given.
Author

N67-36718# Air Force Cambridge Research Labs., Bedford, Mass. Microwave Physics Lab.
RANDOM SCATTERING OF QUASIMONOCHROMATIC RADIATION IN A LONG TRANSMISSION LINE
Joseph L. Poirier Jun. 1967 28 p refs *Its* Phys. Sci. Res. Papers No. 329
(AFCRL-67-0353; AD-655789)

The reflection of quasimonochromatic radiation from random discontinuities in a long transmission line is analyzed using the theory of partial coherence. Graphical probability density functions for the power reflection coefficient at the input to the line are

obtained as a function of the spectral characteristics of the illuminating signal, the properties of the propagation medium, and the distribution of the scatterers. Theoretical expressions for the mean and variance of the power reflection coefficient are also obtained. The mean, variance, and probability density functions for the power reflection coefficient obtained experimentally are compared with the theoretical results and show good agreement.
Author (TAB)

N67-36719# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
EIGENELEMENTS OF THE FINITE FOURIER TRANSFORM AND THEIR APPLICATION TO ANTENNA PATTERN SYNTHESIS
Thomas S. Fong Dec. 1966 59 p refs
(Contract AF 19(628)-4349)
(PG7-93; SR-8; AFCRL-67-0342; AD-655791)

The eigenvalues and eigenfunctions of the finite Fourier transform corresponding to parameter c = 10 pi, 15 pi, 20 pi, and 25 pi are computed and tabulated. The computational details are given and discussed. An antenna pattern synthesis technique that makes use of these eigenelements is illustrated by examples. When the superdirective ratio is constrained to reasonable values, the number of eigenfunctions that contribute significantly to the pattern is found to be approximately equal to twice the number of wavelengths in the aperture. A pattern synthesized with the above eigenfunctions is compared with the pattern obtained by Woodwards method.
TAB

N67-36749*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37-36, VOLUME III FOR THE PERIOD SEPTEMBER 1, 1966 TO OCTOBER 31, 1966. THE DEEP SPACE NETWORK
30 Nov. 1966 73 p refs
(Contract NAS7-100)
(NASA-CR-86790; JPL-SPS-37-36, Vol. III) CSCL 17B

Technical systems design, tracking stations engineering and operations, and communications engineering and research development are reported for the Deep Space Network (DSN). Attention is given to the monitoring system, monitor area, and the communications theory model of the DSN ground communications system. Goldstone operations are described; as are real time computation, plotting, and transmission of Mariner IV occultation data. Communications engineering reports progress on S-band implementation, the 100-kw S-band final amplifier, Mariner IV 100-kw CW transmitter, the 100-kw klystron dual carrier test, lunar and planetary radar module, and automatic checkout equipment for the ranging subsystem. Communications research reported include an experimental closed cycle refrigerator for masers, CW signal power calibration with thermal noise standards, simultaneous lobing radiometric tracking system, two-way RF carrier acquisition, Venus station operations, frequency generation and control, and information systems.
M.W.R.

N67-36763*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
HETERODYNE PHASE SHIFTER WITH INDUCTIVE DELAY LINE PICKUP PROVIDES STEPLESS PHASE SHIFT
George B. Robinson Sep. 1967 53 p refs
(NASA-TN-D-4111) CFSTI: HC $3.00/MF $0.65 CSCL 09F

This paper describes the design and construction of a phase shifter which provides calibrated phase shift in a continuous 360° range of a sine-wave input signal. The circuit produces phase shift indirectly by introducing a differential phase shift, via calibrated delay lines, to a fixed frequency carrier. The carrier is mixed with the signal to generate a single sideband by means of a balanced mixer followed by a crystal filter. The single sideband is then reheterodyned with the carrier in a second mixer to restore the original frequency. The restored signal phase angle relative to the input signal is equal to the relative phase between the carrier inputs to the first and second mixers. Variable phase output from the calibrated delay lines is obtained by means of an inductive toroid pickup resembling a tape recorder head; this avoids the uncertainty associated with sliding contacts and provides a controlled phase shift characterized by infinite resolution. Linearity of phase control in a 360° range is ±2° and is independent of the input signal frequency. Second harmonic distortion of the output signal is −50 db below the fundamental with a 0.5-volt input signal level. The operating range is 30 to 200 kHz, with a carrier frequency of 10.580 MHz and 300 to 500 kHz, with a carrier frequency of 10.258 MHz. The transistorized circuit is temperature compensated.
Author

N67-36779# Aerospace Corp., El Segundo, Calif. Plasma Research Lab.
ANTENNA BREAKDOWN IN HIGH-TEMPERATURE AIR
Glenn C. Light and Edward C. Taylor Jun. 1967 31 p refs
(Contract AF 04(695)-1001)
(TR-1001(2220-10)-3; SSD-TR-67-118; AD-656336)

Investigations of antenna breakdown in high-temperature air are reviewed to show significant discrepancies between theoretical results and observations. It is argued on theoretical grounds that the discrepancies are due to the temperature-dependence of the electron-molecule energy transfer rate and that the conventional theory can be modified to take account of this effect. Experimental measurements obtained in shock-heated air are presented to confirm and quantify these conclusions. The relevance of these results to antenna breakdown on reentry vehicles is discussed.
Author (TAB)

N67-36821# Naval Weapons Center Corona Labs., Corona, Calif.
RADIATION EFFICIENCY OF VARIABLE-WAVE-VELOCITY HORIZONTAL ANTENNA NEAR THE EARTH
Elwin W. Seeley and Robert D. Smith (Astrophysics Res. Corp., Norco, Calif.) 1 Aug. 1967 25 p refs
(NOLC-730; AD-656397)

Measurements were made on a horizontal conductor near the earth with periodic series capacitance inserted to control the wave velocity along the antenna. Increases in radiation efficiency as great as 15-fold were observed. The correlation between theoretical and experimental antenna efficiency was fair.
Author (TAB)

N67-36858 Royal Aircraft Establishment, Farnborough (England).
DEVELOPMENT OF A CONTACTLESS M-TYPE TRANSMITTER
P. A. Stickels Oct. 1966 20 p
(RAE-TR-66334)

The brushless transmitter using a photoelectric method for sensing angular position is described. Six encapsulated silicon photovoltaic cells are spaced equally around the periphery of a stationary disk of insulating material in a standard housing and are illuminated by a lamp in the center of the housing. The electronic switching circuits are discussed and diagrammed, and the electric properties and accuracy measurements are tabulated and graphed. It is concluded that the M-type transmitter has advantages over the mechanical units with respect to accuracy, life, and speed of operation. Tests showed the transmitter capable of controlling a load of size 11 repeater motors at 85°C.
N.E.N.

N67-36866* International Business Machines Corp., Owego, N. Y. Electronics Systems Center.
STUDY PROGRAM TRANSMITTING INFORMATION BY OPTICAL ELECTRONICS (TIBOE) Final Report
[1964] 68 p refs
(Contract NAS10-2412)
(NASA-CR-88624; IBM-66-928-062) CSCL 09F

The requirements and detailed description of a laser system which can transmit information between a space vehicle and a launch platform by optical electronics are presented. The optical transmitters chosen for the demonstration are GaAs injection lasers operated without cooling. Pulse modulation schemes, including pulse-position (PPM), pulse-frequency (PFM) and PCM are utilized. Wide-beam transmitter and receiver optics are used to accommodate the large relative transverse motion expected between the vehicle and the Launch Umbilical Tower (LUT). Data curves and calculations for the performance of the system are given. L.S.

N67-36908# Airborne Instruments Lab., Inc., Mineola, N. Y.
RESEARCH ON COMPACT AND EFFICIENT ANTENNAE Final Report, 1 Apr. 1966–31 Mar. 1967
J. F. Ramsay, B. V. Popovich, and J. F. Gobler Jul. 1967 166 p refs
(Contract DA-28-043-AMC-02111(E))
(AIL-1748-1; ECOM-02111-F; Rept.-2; AD-656479)

To investigate the limitations of electrically small tactical HF communication antennas used over ground, measurements were made on scale model UHF antennas mounted on model UHF ground. The antennas used were dipoles or monopoles with groundplanes. The model ground consisted of a carbon-loaded polyurethane elastomer, designed to simulate HF ground at UHF. Measurements on the model antennas over the model ground resulted in agreement with theory where theory existed, and allowed comparison and evaluation of arbitrary antenna configurations and ground systems. The ground modeling technique proved especially valuable in determining the groundwave attenuation rate at relatively short ranges, and in investigating a figure of merit, rather than an efficiency, for an antenna intended for groundwave communications. It was found that a relatively small ground sample could provide data useful in determining the antenna performance. Theoretical studies were carried out to determine the magnitude of the power lost in the local region of an antenna of arbitrary configuration, and to predict the field at, or near, the antenna region and at long ranges for both dipole and groundplane antennas. This report contains a recommendation that typical uniform grounds be given standardized ground constants. Tables and graphs of the reflection coefficients versus angle of incidence of representative grounds were prepared for frequencies in the HF and VHF bands. Author (TAB)

N67-36928# New Mexico State Univ., Las Cruces. Physical Science Lab.
A 1680 MHz ANTENNA FOR A TWENTY-FOUR INCH EJECTABLE SPHERE Interim Scientific Report
H. W. Haas, D. G. Henry, and B. T. Buller Feb. 1967 38 p refs
(Contract AF 19(628)-5923)
(AFCRL-67-0238; SR-1; AD-655805)

The PSL Model 24.006 quadraloop antenna was developed as a 1680 MHz telemetry antenna. The antenna is mounted on an ejectable twenty-four inch sphere, which is ejected from an Arcus type rocket. The antenna is designed to fit inside a nylon housing attached to the metal strut of the sphere. The Model 24.006 antenna was tested for radiation pattern, VSWR and mechanical integrity. Author (TAB)

N67-36939# Naval Ordnance Lab., White Oak, Md.
ON THE STATISTICAL PROPERTIES OF TRANSIENT NOISE SIGNALS
Edward C. Whitman 8 Mar. 1967 74 p refs
(NOLTR-67-25; AD-655228)

A class of random transient signals has been defined as the product of a deterministic envelope waveform of finite integral square and a continuous random process with a well-defined power spectrum and autocorrelation function. The time average autocorrelation function and energy density spectrum of the resulting waveform have been found to be random variables at every value of their arguments. The means and variances of these random variables are derived as functions of the characteristics of the envelope and original noise process. The average autocorrelation function is found to be the product of the autocorrelation functions of envelope and noise, and the average spectrum is given by the convolution of the energy spectrum of the envelope function and the power spectrum of the noise. Examples of the mean and variance calculations are presented for both rectangular and decaying exponential pulse of both broad and narrow band noise. Finally, the implications of these findings for measurement programs and monopulse signal processing are discussed. Author (TAB)

N67-36965*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37–46, VOLUME III FOR THE PERIOD MAY 1 TO JUNE 30, 1967. THE DEEP SPACE NETWORK
31 Jul. 1967 251 p refs
(Contract NAS7-100)
(NASA-CR-88553; JPL-SPS-34-46, Vol. III) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Summary data are presented on the research projects directed toward developing new components and systems for two-way communications with unmanned spacecraft traveling approximately 10,000 miles from earth to interplanetary distances. Tracking and navigational accuracy analyses are being conducted on the effects of medium-term oscillator stability on two-way Doppler data precision and orbit accuracy; station and probe location effects on the information content of a single pass of Doppler data; statistical formulas for double precision orbit determination; and Sun–Earth line plots. Digital communication and tracking aspects are being studied, along with ultracone antenna systems, Fortran programs, and calibration techniques. Engineering interest centered on transmitters, system noise temperature reduction, and antenna structures. Flight project support is discussed in relation to facility engineering, operations, construction, and equipment. The multiple-mission telemetry system is described in terms of the complete system, specifications, system analysis, equipment and software, and preliminary test results. M.G.J.

N67-36972# Mitre Corp., Bedford, Mass.
THE INVERSE DIFFRACTION PROBLEM: ANALYSIS OF SPECULARS
Jun. 1967 18 p refs
(Contract AF 19(628)-5165)
(MTR-252; ESD-TR-67-91; AD-655797)

Specular returns from radar targets contain large power which makes a technique based on the analysis of speculars attractive. Herein, the specular returns from a flat region and from a smooth surface tangent to a plane along a curve, which are the largest returns for reasonably sized bodies, are used to obtain information about the geometry of the target. Author (TAB)

N67-37021*# Stanford Research Inst., Menlo Park, Calif.
OGO-1 VLF EXPERIMENT A-17 DIGITAL DATA PROCESSING SYSTEM Final Report
B. P. Ficklin, M. E. Mills, W. E. Blair, N. D. Schlosser, J. H. Wensley et al Apr. 1967 112 p refs
(Contract NAS5-2131; SRI Proj. 4007)
(NASA-CR-88618) CSCL 09F

The digital data processing technique of the VLF radio noise and propagation experiment (A-17) aboard the OGO-I satellite is examined. Descriptions, operational procedures, and details of the instrument and satellite are given as required for understanding of the data processing system. Data acquisition, decommutation, and processing systems are briefly described. The input, output, and operation of the four-phase data-processing system are presented in detail. The computer display system and 16-mm cine film presentation are also described, and examples are shown. On more than 2×10^5 frames of film, 2×10^8 experimental digital data bits of information covering 99 satellite revolutions have been plotted and stored. This accumulation of data represents more than 10^5 bits of information per frame and was computer processed at approximately three frames per second. This cine film technique provides capability for significant data compacting, quick data scanning, discrimination between signals and interference, recognition of unique data characteristics, and simultaneous data comparison.
Author

N67-37023* Massachusetts Inst. of Tech., Cambridge. Center for Space Research.
SUNBLAZER RECEIVER PERFORMANCE FOR A NOISY, DISPERSIVE CHANNEL
Robert S. Pindyck and James L. Mannos Aug. 1967 71 p refs
(Contract NASr-249)
(NASA-CR-88614; CSR-TR-67-6) CSCL 17B

The performance of the Sunblazer phase modulation communication scheme is examined with regard to signal detection. Specifically, the optimum performance threshold is determined, and the statistics for the error probabilities (P_M and P_F) are derived. The total probability of error is then calculated for the case of an eleven-bit Barker Code as a function of four system parameters: the a priori probability that the signal is present, the signal-to-noise ratio, the dispersion ratio, and the correlation miss time. These results show that when the operating conditions are poor it is often better to base the decision as to the signal's presence only on the a priori knowledge, without even observing the correlation output. It is shown how the threshold could be better selected if the dispersion ratio and miss time could be predicted in advance.
Author

N67-37028*# Astro Research Corp., Santa Barbara, Calif.
SPINNING PARABOLOIDAL TENSION NETWORKS
William M. Robbins, Jr. Washington, NASA, Sep. 1967 33 p ref
(Contract NAS7-426)
(NASA-CR-873; ARC-R-240) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The requirements for forming a spinning paraboloid of revolution from perfectly flexible fibers are investigated. It is shown that such a surface can be made with two symmetrically placed sets of spiral fibers, either with or without a parallel-circle set. In either case there is a minimum radius at which a given design must be truncated and which, for reasonable surface geometry, limits the ratio of outer to inner radius to two or less. Author

N67-37033# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
DYNAMIC EVALUATION OF RADAR AND PHOTO TRACKING SYSTEMS
Walter B. Miller and Henry Rachele May 1967 25 p refs
(ECOM-5128; AD-656738)

Use of radar and multiple phototheodolites for obtaining wind velocity data has become common at WSMR in recent years. These systems yield position and velocity data at a much faster rate than conventional theodolite systems. Since the limitations of data obtained with radar and phototheodolites are not well known to the meteorologist, this study was undertaken to investigate some of these problems from a meteorologists viewpoint. Several fundamental problems were investigated. Some are due to the geometry of the trackers relative to the balloon and others to the mathematics of processing the basic data. It was found, for instance, that estimates of the position components (x,y,z) are affected by the mathematics of transforming from the basic observations range, azimuth and elevations. It was also found that there are advantages to using the range, azimuth and elevation (R,A,E) coordinate system in performing a dynamic evaluation of the tracking system. Finally, care must be exercised in performing a dynamic evaluation or a strong possibility of underrating the system can result due to geometry alone.
Author (TAB)

N67-37048# Navy Electronics Lab., San Diego, Calif.
FALSE ALARM PROBABILITY OF A QUADRATURE CLIPPER CORRELATOR FOR POISSON NOISE PROCESS Research Report, Sep. 1965-Jan. 1966
C. S. Stradling 28 Apr. 1967 32 p refs
(NEL-1458; AD-655244)

By means of a mathematical model, it was shown that the false alarm probability of a quadrature clipper correlator for a Poisson noise process is a function of both the noise bandwidth and the sampling rate. The same analytical technique is applicable to a wide variety of correlation systems which process data in clipped form.
Author (TAB)

N67-37053# General Dynamics/Convair, San Diego, Calif.
DEVELOPMENT OF AN OCEAN DATA STATION TELEMETERING BUOY Progress Report
Dec. 1966 119 p refs
(Contract Nonr-3062(00))
(GDC-66-093; AD-655618)

The report describes recent activities and results in a program to develop a general-purpose ocean data station buoy and associated shore-based mobile data facilities to be used to acquire oceanographic and meteorological data in scientific experiments at sea. The telemetry and command single-sideband radio equipment being installed in the buoys is capable of operating over distances of at least 2,500 miles (4,022 km) using ordinary ionospheric short-wave propagation, but makes use of the most recent techniques in information encoding to use radio spectrum bandwidth most efficiently and effectively. The experimental operation of prototype BRAVO is covered. The report describes the Mobile Data Center being prepared for use with the prototypes, permitting long range interrogation of the buoy and reception of environmental data acquired by the buoy. Subsystem tests and results are reported, including developmental testing of the anti-collision light and the electric power system. In the case of the electric power system, important new information concerning the extended duration performance characteristics of nickel-cadmium storage batteries is presented. Reliability and performance of a considerable number of commercially available meteorological sensors tested at sea on prototype BRAVO is also reported.
Author (TAB)

N67-37063# Stanford Research Inst., Menlo Park, Calif.
EVALUATION AND PREDICTION OF MAXIMUM USABLE FREQUENCY (MUF) OVER BANGKOK
Clifford L. Rufenach Jan. 1967 75 p refs
(Contract DA-36-039-AMC-00040(E); ARPA Order 371)
(TR-28; AD-655566)

Two sets of corrected monthly median MUF (vertical incidence) predictions are compared against the monthly median observed vertical incidence sounder values over Bangkok for the period April 1965 through August 1966. The comparison showed the definite improvement in accuracy that is the primary requirement for new corrected predictions for 1967. New predictions for 1967 were derived by adding a correction to values obtained from a method developed by Stanford Research Institute, long-term predictions can be prepared for several years in advance with this method. The predictions for 1967, corrected for the Bangkok area, typically vary between about 3 MHz in the early morning to about 10 MHz in the late afternoon. The predicted MUFs for 1967 average about 1 MHz higher than 1966, which means that the 1967 operating frequencies may be increased by about 1 MHz without increasing the expected communication outage. Author (TAB)

N67-37072*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PERFORMANCE OF PHASE-COHERENT RECEIVERS PRECEDED BY BANDPASS LIMITERS
W. C. Lindsey 15 Sep. 1967 20 p refs
(Contract NAS7-100)
(NASA-CR-88523; JPL-TR-32-1162) CFSTI: HC $3.00/MF $0.65 CSCL 17B

In phase-coherent communication systems, where bandpass limiters precede the RF carrier tracking loop, it is of interest to understand how the noisy RF carrier reference affects system performance. This report characterizes a model probability distribution for the RF phase error and uses this to predict the performance of phase-shift keyed and differentially coherent systems of the *Mariner* and *Pioneer* types. For these systems, two physical situations are considered: (1) system performance when the phase error is constant over the duration of one bit, and (2) system performance when the phase error is allowed to vary over the duration of one bit. Author

N67-37172*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE CANTED TURNSTILE AS AN OMNIDIRECTIONAL SPACECRAFT ANTENNA SYSTEM
R. B. Jackson Sep. 1967 26 p refs
(NASA-TM-X-55924; X-712-67-441) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Operation of turnstile antennas on structures noticeable in terms of wavelength is discussed with emphasis on the canted turnstile as an omnidirectional spacecraft antenna system. The normal flat turnstile antenna consisting of two half wavelength dipoles mounted at right angles to each other is described. Its polarization characteristics are defined and illustrated. The canted turnstile is formed from four monopole antennas approximately one quarter wavelength long. Reasons for using the canted turnstile antenna on a spacecraft are given, and the radiation characteristics are compared with the flat turnstile. The effects of spacecraft size and structure on antenna pattern shape are described, and examples of the canted turnstile spacecraft antenna are presented for Ariel I, Explorer 34, E 35, and 32. Finally the matching of antennas is discussed, and the two most efficient feed systems are described. S.P.

N67-37184# Federal Aviation Agency, Washington, D. C. Systems Effectiveness Branch.
COST/BENEFIT ANALYSIS OF TELEVISED RADAR FOR GENERAL AVIATION Final Report
Juel E. Erickson Aug. 1967 44 p refs
(RD-67-54)

An economic evaluation of the costs and potential benefits of broadcasting radar information to general aviation aircraft via TV relay was performed. Benefits were equated to costs of general aviation accidents that might be preventable by broadcasting weather data, area route information, or positions of other aircraft. It was determined that benefits of TV radar would exceed costs if at least 50 percent of all general aviation aircraft installed equipment and also that at least 50 percent of general aviation accidents costs would be eliminated as a result. However, due to the probability of too few participating general aviation aircraft, the study concludes that no justification exists for pursuing the TV radar concept further at this time. Future improvements in radar, transmission capability, frequency availability, and availability of suitable equipment for general aviation aircraft may indicate a need for further reassessment at that time. Author

N67-37188*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RESEARCH AND ADVANCED DEVELOPMENT. VOLUME III: SUPPORTING RESEARCH AND TECHNOLOGY FOR THE OFFICE OF TRACKING AND DATA ACQUISITION (NEW SYSTEMS AND SPACECRAFT SUBSYSTEMS), NATIONAL AERONAUTICS AND SPACE ADMINISTRATION Semiannual Review, 1 Jan.–30 Jun. 1967
31 Jul. 1967 60 p refs
(Contract NAS7-100)
(NASA-CR-88507; JPL-TM-33-353, Vol. III) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Presented is a review of supporting research and technology in the area of tracking and data acquisition (new systems and spacecraft subsystems). Continued research in the following areas is reported: radio frequency techniques engineering; communications systems development; information processing; astrometrics; propagation engineering; low noise transponder preamplifier development; ranging transponder; low data rate MFSK modulation/detection systems development; low data rate telemetry radio frequency systems development; standard telemetry acquisition and demodulation techniques; data compression techniques; and standard telemetry system engineering. S.C.W.

N67-37230# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INDICATORS OF SURVEY RADAR STATIONS
A. S. Magdesiyev and M. M. Reznik 18 Apr. 1967 103 p refs Transl. into ENGLISH of the book "Indikatory Obzornykh Radiolokatsionnykh Stantsiy" Moscow, Vovennoye Izdatel'Stvo, 1963 p 1–128
(FTD-MT-65-254; AD-656560)

The brochure describes the principles of construction and operation of the main units of indicators used for scanning radar stations, the technical characteristics of the indicator apparatus, and also the influence of these characteristics on the tactical features of the radar stations. The brochure contains also some recommendations on the operation of indicator units, and is intended for students in military academies, officers specializing in radio, and for a wide circle of readers interested in radar techniques. Author (TAB)

N67-37237# Naval Ordnance Lab., White Oak, Md. Physics Research Dept.

PERFORMANCE OF A COMBINATION PHASE AND FREQUENCY LOCK SYSTEM

Charles F. Suter, Jr. 3 Feb. 1967 39 p refs

(NOLTR-67-21; AD-655812)

The report deals with the design of a synchronous demodulator for the detection of AM multiplexed signals. The demodulation scheme is unusual in that two separate feedback control loops are employed to lock the local oscillator of the demodulator in phase with the input carrier: a discrete-step coarse control loop for the purpose of handling large errors in frequency, and a conventional phase lock loop for fine control over small frequency and phase errors. A simple linear model of the phase lock loop is employed for the optimization of the phase lock loop. Transition between the coarse and fine control loops is studied in detail by means of numerical analysis of the non-linear region of operation of the phase lock loop. Author (TAB)

N67-37260*# Astro Research Corp., Santa Barbara, Calif.

GRATINGS AND NETWORKS OF RIBBONS AS RADIO REFLECTORS

William M. Robbins, Jr. Washington, NASA, Sep. 1967 19 p ref

(Contract NAS7-426)

(NASA-CR-872; ARC-R-231) CFSTI: HC $3.00/MF $0.65 CSCL 20N

The reflecting properties for electromagnetic radiation, at normal incidence, of a surface formed from gratings or networks of conducting ribbons are analyzed and described in terms of two reflection coefficients. The geometrical reflection coefficient expresses the ratio of reflected to incident power for a grating formed of perfectly conducting elements. The ohmic reflection coefficient expresses the ratio of reflected to incident power for a continuous thin sheet of equivalent surface conductivity. A network of aluminum ribbons, suitable for use in a space environment at a frequency of 4 mc/sec, with a geometrical reflection coefficient of 0.98 and an ohmic reflection coefficient of 0.99 can be made to have a surface mass density of 270 kg/km^2. In comparison, a continuous sheet of aluminum, 0.5 mil thick, has a surface mass density of 34,300 kg/km^2. Author

N67-37336* Spacelabs, Inc., Van Nuys, Calif.

OPERATING MANUAL BIOTELEMETRY SYSTEM

3 Jan. 1967 37 p

(Contract NAS4-1071)

(NASA-CR-88403; SR67-1038) CSCL 06B

Assembly and operating instructions are outlined for the transmitter receiver, and battery charger. The biotelemetry system is described briefly, and the specifications are listed. Circuit diagrams and drawings of components and assemblies are included. N.E.N.

N67-37350# Royal Observatory, Edinburgh (Scotland). Satellite Tracking Section.

KINETHEODOLITE OBSERVATIONS MADE AT EARLYBURN: SATELLITE 1962 BETA-KAPPA 1, OCTOBER 1965–MARCH 1966

Bennet McInnes 30 Mar. 1967 17 p refs

(ROE-STS-61) CFSTI: HC $3.00/MF $0.65

Reduced observations of 12 transits of the satellite 1962 Beta-Kappa 1, also called Starfish Radiation Satellite or Star-rad, made by a cinetheodolite at Earlyburn station are tabulated. During the observation period the perigee was around 200 km and the apogee around 3000 km. ESRO

N67-37366*# Stanford Research Inst., Menlo Park, Calif.

TACTUAL PERCEPTION: EXPERIMENTS AND MODELS Final Report, 24 May 1966–24 May 1967

James C. Bliss Jun. 1967 113 p refs

(Contract NAS2-3649)

(NASA-CR-73135) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Results from an experiment on tactile perception of sequentially presented point stimuli indicate that content errors are constant as the interstimulus interval is increased up to 200 ms, and that sequence errors decrease exponentially with interstimulus interval. Comparisons were made between tracking performance when an airjet stimulator moved horizontally across the forehead and when it moved along the palmar side of the hand and index finger. Performance appeared to be about equal in these two cases. Results from critical tracking with both visual and tactile displays indicated a greater effective time delay with the tactile display. In the reaction-time experiments, subjects could receive either tactile or visual stimuli, or both simultaneously, on any one trail. The results are consistent with a model which assumes that the sensory input channels are independent of each other, and that subjects tend to respond to the first perceived stimulus. Also described are developments for conducting a wide variety of experiments on tactile perception, which range from presentation of multiple point stimuli to analyses of describing functions in tracking experiments. Author

N67-37441 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

ANALOGY SIMULATION BY MEANS OF A NETWORK OF THE ELECTROMAGNETIC RADIATION FROM AN ANTENNA OF REVOLUTION IN VACUUM AND IN A PLASMA [SIMULATION ANALOGIQUE DU RAYONNEMENT ELECTROMAGENTIQUE D'UNE ANTENNE DE REVOLUTION DANS LE VIDE PUIS DANS UN PLASMA A L'AIDE D'UN RESEAU]

J. Fritz 1967 40 p refs In FRENCH; ENGLISH summary Presented at the 5th Congr. of the Intern. Assoc. for Analogical Calculus(AICA), Lausanne, France, 28 Aug.–2 Sep. 1967

(TP-510(1967))

The interest of an original analog calculation method applicable to the study of an antenna of revolution radiating in any medium is shown. The principle of the simulation adopted and the design and construction of a network representing a radiating dipolar sphere are described. The choice of such an antenna was dictated by the fact that a theoretical calculation of radiation in vacuum was still possible with this geometry, this theoretical calculation permitting to justify the method. The experimental results are exposed and they are compared with theory. A homogeneous plasma uniformly distributed around the radiating sphere is introduced. The main application is described. The calculation of an antenna of a shape similar to the ogive of a rocket is proposed in an analog form and the simulation of a homogeneous plasma around a re-entry body is adopted. Author

N67-37491*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

THE PRINCIPAL FACTORS DETERMINING THE DIRECTIONAL PATTERN OF A DIELECTRIC ANTENNA

G. Zh. Rankis Redstone Arsenal, Ala., Redstone Sci. Inform. Center, 3 Jul. 1967 12 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Radiotekhn. (Kiev) Prepared jointly with Army Missile Command

(NASA-TM-X-60335; RSIC-686) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The directional pattern of a dielectric antenna is analyzed on the basis of integral equations. Additional factors are established which determine the difference of the directivity pattern of a real antenna from an idealized linear travelling-wave antenna: direct

radiation of the exciting junction, a supplementary field in the region of the exciting junction, etc. Estimates of the magnitude of their influence were obtained for different varieties of dielectric antennas. The properties of conical dielectric antennas are briefly examined. Author

N67-37508*# Washington Univ., St. Louis, Mo. Dept. of Economics.

SOME ECONOMIC PROBLEMS OF INTERNATIONAL SPACE TELECOMMUNICATIONS, VOLUME II

Edward J. Heiden Aug. 1967 130 p refs *Its* Working Paper 6711

(Grant NsG-342)

(NASA-CR-88638) CFSTI: HC$3.00/MF$0.65 CSCL 17B

Processes and data sources used in generating comprehensive estimates of 1968 to 1975 worldwide intelsat communication system requirements are described. System requirements are based on telephone, telegraph, telex, and television transmission modes. A detailed discussion is presented of the five annual operating expenses and the six assets (the "going concern", command and control center, orbiting satellite, ground stations, working capital, and general and administrative assets) of the intelsat system. Included in the tabular data is a recapitulation for 1971 and 1975 of total hourly circuit requirements of developed, underdeveloped, and mixed (developed and underdeveloped) communicating regional pairs supported by either Atlantic, Pacific, or Indian Ocean satellite coverage. An extensive bibliography of source materials is included. E.C.

N67-37526# General Motors Corp., Santa Barbara, Calif. Microwave Physics Lab.

RADAR INVESTIGATION OF THE WAKES OF BLUNT AND SLENDER HYPERSONIC VELOCITY PROJECTILES IN THE BALLISTIC RANGE

S. Zivanovic, P. E. Robillard, and R. I. Primich *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 2 May 1967 35 p refs (See N67-37521 22-12)

(Contract DA-01-021-AMC-11359(Z))

The study and experimental results of scattering of electromagnetic waves in the millimeter wavelength range from the wakes of hypersonic projectiles are presented. The four radars employed for the measurements are briefly described and their advantages and limitation are discussed. The results obtained from wakes of both blunt and slender bodies are discussed in some detail. The wake radar cross-section, velocity, and location of the various transition phenomena can be obtained directly from the measured amplitude and the phase of the returned signal. In addition, various statistical properties of wake scattering, such as spatial correlation function, probability distribution function, and spectra of wake fluctuation can be obtained. Author

N67-37561# Air Force Cambridge Research Labs., Bedford, Mass. Aerospace Instrumentation Lab.

DISTRIBUTIONS OF RADAR ECHOES OVER THE UNITED STATES

Donald D. Grantham and Arthur J. Kantor Apr. 1967 365 p refs *Its* Surv. in Geophys. No. 191

(AFCRL-67-0232; AD-656310)

The frequency and probability of radar echoes of convective clouds over the United States are presented. Analysis of three years of observations from a 31-station WSR-57 weather radar network indicates that at all altitudes, radar echo probabilities are greatest over Florida and the Gulf coast, generally decreasing northward over the United States. Also, largest probabilities for most layers and locations occur in summer. Echoes have been reported up to at least 70 kft in May, June, and July, and up to 60 kft in winter. Diurnal variations reveal greatest probabilities between 1600 and 2100 LST in all regions. Largest mean monthly 3-hour values are 85 percent, and the maximum mean daily range is roughly 65 percent in the southeast during the summer months. The probability of an echo-free horizontal view near the earths surface for a 100-mile range is also presented. Tabulations of echo-free sectors, as percent of the 360-degree radar scope, show that the probability of obstructions to a horizontal view increases generally from northwest to southwest during all seasons. The probability of having no echoes is greater in winter than in summer except along the Pacific coastal region. Diurnal variability is larger in July than in January. Author (TAB)

N67-37574* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

AOPB SYSTEMS MANUAL: PROGRAM DESCRIPTION. ORBITAL TRACKING DATA ANALYSIS PROGRAM

Apr. 1967 81 p

(NASA-TM-X-55926; X-542-67-232) CSCL 17I

An orbital tracking program (ODTA) for analysis of data obtained from C-band and S-band radar is described. The ODTA program provides information useful in the noise analysis of range, and range-rate data, the resolution of ambiguities in the observations themselves, and the determination of bias in radar data. The basic requirement for the program is to provide data about periodicity, if any, and noise analysis. This is accomplished by doing differences to determine which degree polynomial must be used to fit the data, by fitting that polynomial, and by forming the residuals of the fitted vs raw data. The program consists of three parts: conversion of input, analysis of data, and generation of a tape for the differential corrector program, which is divided into 17 overlays or links. Flow charts are included for the main routine, the subroutine, the data analysis program, and the differential corrector tape generator routine. S.P.

N67-37652# International Business Machines Corp., Gaithersburg, Md.

LASA SIGNAL PROCESSING, SIMULATION, AND COMMUNICATIONS STUDY Final Report, Feb. 14, 1966-Jan. 14, 1967

J. H. Cochrane et al Bedford, Mass., AFSC, Electron. Systems Div. Mar. 1967 384 p refs

(Contract AF 19(628)-5948; ARPA Order 800)

(ESD-TR-66-635; AD-655802)

A summary of findings correlates the results with factual detail reported earlier. Signal processing is discussed; further system and simulation studies are reported; suggested system implementation is extended; and the set of simulation programs used in the study is described. Author (TAB)

N67-37683# Lincoln Lab., Mass. Inst. of Tech., Lexington.

EARTH COVERAGE FROM A CIRCULARLY SYMMETRIC SHAPED-BEAM ANTENNA ON A SYNCHRONOUS SATELLITE

J. Bruce Rankin 27 Jun. 1967 46 p refs

(Contract AF 19(628)-5167)

(ESD-TR-67-321; TN-1967-29; AD-656707)

Calculations were made to show the earth illumination from circularly symmetric antennas on synchronous satellites. The antenna directive gain is calculated as a function of antenna size, beam shape, intended beam pointing direction, error in the pointing direction, and the fraction of the earth surface illuminated. Author (TAB)

N67-37693 Library of Congress, Washington, D. C. Aerospace Technology Div.
COMMUNICATIONS NETWORKS Surveys of Foreign Scientific and Technical Literature
W. Podpaly 21 Sep. 1967 37 p refs *Its* Work Assignment No. 33
(ATD-67-41; Rept.-8)

Abstracts are included for 15 references from Soviet open-source literature dealing with communications equipment and communications facilities and their location. Source code numbers are presented for each of the references, all of which can be found at the Aerospace Technology Division of the Library of Congress. M.W.R.

N67-37708# Indiana Univ., Bloomington. Hearing and Communication Lab.
RECEIVER OPERATING CHARACTERISTICS DETERMINED UNDER SEVERAL INTERAURAL CONDITIONS OF LISTENING
David S. Emmerich Jul. 1967 104 p refs
(Grant AF-AFOSR-548-67)
(AFOSR-67-1561; AD-655386)

The ability of subjects to detect sinusoidal signals in a continuous background of white gaussian noise was investigated for several different interaural relations of the signal and of the noise stimuli. The functions relating the proportion of correct detections of the signal to the proportion of false alarms were determined in each case. These functions are referred to as receiver operating characteristics, or ROCs. A rating procedure was employed to determine the ROCs. The area under the ROC was found to be a good estimate of the percent correct obtained with a two-interval forced-choice technique -- a relation to be expected on theoretical grounds. The ROCs were not significantly affected by the presence of trial-by-trial feedback. In addition, the ROCs obtained when signals of differing intensity were mixed in blocks of trials were found to be quite similar to those obtained when only one signal intensity was presented in any given block of trials. Author (TAB)

N67-37781# Lincoln Lab., Mass. Inst. of Tech., Lexington.
RADIATION CHARACTERISTICS OF LOOP ANTENNAS EXCITED BY TRANSIENTS
Andre R. Dion 14 Apr. 1967 20 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-238; TR-433; AD-656345)

The radiation characteristics of a rectangular loop loaded at its mid-point with a resistance equal to the radiation resistance, and fed by dc pulses, are derived and compared with measurements. In particular, the time variation of the electromagnetic pulse radiated by this antenna, and also of the voltage pulse induced at the terminals of a similar receiving antenna, is derived. The relationships between the characteristics of these pulses and the loop parameters are stressed. Author (TAB)

N67-37808# Space Sciences, Inc., Waltham, Mass.
ELECTRON ATTACHING ADDITIVES FOR THE MODIFICATION OF RE-ENTRY PLASMAS
Sander E. Nydick and Sol Aisenberg 17 Mar. 1967 37 p refs
(Contract AF 19(628)-5097)
(AFCRL-67-0214; SR-1; AD-656494)

The report is part of an analytical and experimental program to investigate the enhancement of microwave communication by employing small quantities of chemical additives introduced into the plasma sheath of a re-entry vehicle and to deduce the optimum types and forms of additives to be used. An analytical investigation has shown that electron attachment to electrophylic molecules is one of the more important mechanisms in reducing the plasma free electron concentration and thereby in alleviating the re-entry sheath black-out problem. The attachment cross section data necessary for the theoretical selection of the more effective additives is not always available in the literature. An analysis is presented here, where attachment cross sections are correlated with more readily available fundamental thermodynamic data so that attachment data can be predicted. Qualitative reasoning based upon the potential energy diagram concept is employed to describe the physics of electron attachment and to derive graphical correlations between the more readily obtained thermodynamic values and the attachment cross-section parameters. Average attachment rate constants are also calculated for molecules from data in the literature. The attachment rate constant can be employed as a figure of merit to determine the most efficient additive, for the limiting case of negligible dissociation. The results show that carbon tetrachloride is the most efficient of the compounds investigated and is potentially at least two orders of magnitude better than water for moderate plasma temperatures. Author (TAB)

N67-37809# Lincoln Lab., Mass. Inst. of Tech., Lexington.
RESPONSE OF SEISMIC ARRAYS TO WIDE-BAND SIGNALS
Edward J. Kelly 29 Jun. 1967 51 p ref
(Contract AF 19(628)-4167)
(TN-1967-30; ESD-TR-67-320; AD-656344)

Response patterns are computed for the LASA and other arrays and for a class of wide-band signals. Results are displayed as contour plots in wavenumber space and in real space, with and without P-wave attenuation. Author (TAB)

N67-37859# General Electric Co., Syracuse, N. Y. Heavy Military Electronics Dept.
DECOUPLED MONOPULSE EXCITATIONS FOR MAXIMUM GAIN WITH ARBITRARY SIDELOBE CONSTRAINTS Interim Scientific Report
Richard R. Kinsey Apr. 1967 64 p refs
(Contract AF 19(628)-5905)
(AFCRL-67-0332; Rept.-68707-SR-1; SR-1; AD-655391)

Monopulse antenna patterns can be conveniently obtained by phase comparing the two halves of an equiphased line source aperture. The generally unsatisfactory sidelobe performance of this type antenna has, however, seriously limited its application. A mathematical derivation and physical interpretation of line source excitations which maximize sum gain, subject to sum and difference pattern sidelobe constraints, are presented in this report. A computer program to solve for the required excitation coefficients is outlined and the Fortran IV listing is appended. Numerical examples are included for a representative number of practical cases and one of the derived aperture excitations is selected as the design basis for an experimental linear array. A discussion of the array feed design is followed by a summary of laboratory and pattern range measurement data. Author (TAB)

N67-37886# Army Electronics Labs., Fort Monmouth, N. J.
DESIGN OF AN INTEGRATED WIDE-BAND AMPLITUDE-MODULATED NOISE SOURCE
Russell A. Gilson and Randolph A. Reitmeyer, Jr. May 1967 20 p refs
(ECOM-2829; AD-655258)

The report describes the results of a project directed towards designing and constructing a miniature, wideband, AM-modulated, noise generator. The modulated noise generator is a circuit that

can test the operational performance of a typical AM receiver on a go no-go basis. In other words, this single circuit serves and accomplishes the same task (without electronic tuning) that a tuneable, modulated, signal generator does when making operational tests on AM receiving equipment. The report also discusses the selection of the noise source and audio oscillator used to amplitude modulate the noise source. It is seen that by choosing an audio relaxation oscillator to drive a single diode as a noise source, a circuit may be realized that may be fabricated using hybrid integrated circuit techniques. The impact of the hybrid integrated circuit techniques is that the noise generator size is substantially reduced to the point that it may be incorporated in the actual AM receiver to be tested. Author (TAB)

N67-37881*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DEMODULATION OF AMPLITUDE MODULATED R.F. WAVES IN A PLASMA AT RESONANCE
Nobuki Kawashima Aug. 1967 22 p refs
(NASA-TM-X-55917; X-615-67-377) CFSTI: HC $3.00/MF $0.65 CSCL 17B

A laboratory simulation experiment was performed to study the mechanism of the detection of audio waves from nearby radio broadcasting stations by spacecraft-borne audio detectors in the ionosphere, where the carrier frequencies of the detected radio stations seem to depend on the altitude of space probes within the ionosphere. The dependence of the carrier frequency on the altitude is explained as a result of series resonance of an inductive plasma with the sheath capacitance. For a higher modulation frequency, the audio output has a phase lag due to the integration by a high plasma and sheath impedance. The audio output has a strong dependence on the potential of the receiving electrode (antenna) with respect to the plasma, and it reverses the polarity at the potential where the second derivative with respect to the voltage of the voltage-current characteristic of the receiving electrode in plasma is equal to zero. For higher potentials, the amplitude of the audio output shows a large broad maximum, and more than an order of magnitude larger output can be obtained than that with the ordinary resonance prove. Author

N67-37922*# Research Triangle Inst., Durham, N. C.
SURVEYOR LANDING RADAR TEST PROGRAM REVIEW Final Report
D. F. Palmer, P. Gene Smith, and G. V. Borgiotti 24 Jan. 1967 194 p Prepared for JPL
(Contracts NAS7-100; JPL-951603)
(NASA-CR-88883; RTI-TRR-33) CFSTI: HC $3.00/MF $0.65 CSCL 17I

The purpose of the study is to review the present program and to recommend desirable and realistic modifications in order to achieve a higher confidence level in the ability of the Surveyor Radar Altimeter and Doppler Velocity Sensor (RADVS) system to aid in soft lunar landings. The radar system and certain parts of the test program are explained, and the basic tenets of a test program philosophy are developed. Detailed studies of a desirable test program and of the current test program were conducted; to reduce biases of the former program by knowledge of the latter, these tasks were undertaken as independently as possible. The present test program was evaluated by comparing it with the desirable program, and a set of test modifications is suggested. The major weakness of the present RADVS test program appears to be in the area of design verification, particularly in investigations of sidelobe signal pickup, transmitter–receiver leakage effects, and retro tankage echo discrimination. The present flight acceptance test program seems to be basically complete except for absence of full simulation of retro engine induced stresses. Documentation of the present program appears to be adequate except for procedures listings. K.W.

N67-37941*# IIT Research Inst., Chicago, Ill. Astro Sciences Center.
TELEMETRY COMMUNICATIONS GUIDELINES
M. Stein Aug. 1967 41 p refs
(Contract NASr-65(06))
(NASA-CR-88859; S-3) CFSTI: HC $3.00/MF $0.65 CSCL 09B

The information transfer capability of spacecraft telemetry communication systems is considered in order to provide general guidelines for the 1975 to 1980 space missions. Major limitations to a communication system are identified as the maximum available transmitter power, size and characteristics of the transmitting and receiving antennas, free space propagation loss, receiving system sensitivity, and modulation method. Transmission capabilities are estimated as a function of the distance of the spacecraft from earth, spacecraft transmitter power level, and sizes of spacecraft and ground antennas. Error coding techniques for improving the theoretical maximum data rate are discussed, which would be effective up to a factor of 6.5. A minimum weight configuration is given to indicate how a minimum total communications weight may be achieved. Transmission rate equations are derived, together with equations to determine the minimum transmitter system weight. M.G.J.

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N67-36695# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
AUTOMATED INPUT/OUTPUT DIAGNOSTICS FOR A REAL-TIME SIMULATION RESEARCH SYSTEM Technical Report, Apr. 1964–Apr. 1965
Don R. Gum and Patricia A. Knoop Oct. 1966 167 p refs
(AMRL-TR-66-133; AD-655771)

The report describes a library of automated diagnostic test-programs for the real-time input/output section of a digital training simulation research system. The application of such automated test to simulation-system acceptance testing is explored. Included is a description of real-time simulation as a training technique and the Real-Time Simulation Research Systems (RTSRS) for which the test-programs were prepared. Detailed program listings, flow charts, and abstracts of each test and of utility subroutines are also provided. Author (TAB)

N67-36748# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
THE BBN 940 LISP SYSTEM Interim Scientific Report
Daniel G. Bobrow, D. Lucille Darley, L. Peter Deutsch, Daniel L. Murphy, and Warren Teitelman 15 Jul. 1967 138 p ref
(Contract AF 19(628)-5065; ARPA Order 627)
(BBN-1539; AFCRL-67-0458; SR-9; AD-656771)

The report describes the LISP system implemented at BBN on the SDS 940 Computer. This LISP is an upward compatible extension of LISP 1.5 for the IBM 7090, with a number of new features which make it work well as an on-line language. These new features include tracing, and conditional breakpoints in functions for debugging and a sophisticated LISP oriented editor. The BBN 940 LISP SYSTEM has a large memory store (approximately 50,000 free words) utilizing special paging techniques for a drum to provide reasonable computation times. The system includes both an interpreter, a fully compatible compiler, and an assembly language facility for inserting machine code subroutines. Author (TAB)

N67-36759# Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.
INVESTIGATIONS IN COMPUTER-AIDED INSTRUCTION AND COMPUTER-AIDED CONTROLS Final Report
R. C. Rosenberg, S. G. McCandlish, and T. B. Sheridan Apr. 1967 29 p refs
(Contract AF 19(628)-3317)
(DSR-9960-4; ESD-TR-67-289; AD-655374)

A summary is presented of two research projects in the area of computer-aided instruction and man-computer interaction. In 1965 Rosenberg completed a study entitled Computer Aided Teaching of Dynamic System Behavior (AD-640 681). This study demonstrated that within the delimited area of formal engineering theory a computer simulated laboratory could be built in which freshman students could pose problems, observe displays of machine responses, and thereby learn formal discipline with only minor interaction with a human teacher. An outline of Rosenbergs experiment and conclusions is given in this report, along with some more general Observations on the Use of Computers in Instruction, dealing with prospects for computerized tracking monitors. In June 1966 McCandlish completed a study entitled A Computer Simulation Experiment of Supervisory Control of Remote Manipulation, (to be published). McCandlish summarizes how, for a formally well-defined task like grasping a block with a pair of jaws, removing the block from a hole and placing it in a second hole, the human can perform the task through the computer, but only with certain difficulties. He investigated such display rate, time delay between human responses and knowledge of results, and nature of command statements. An outline of McCandlishs experiment and conclusions is given in this report followed by Observations on the Relation Between Computer-Aided-Instruction and Computer-Aided-Control, the latter being where the human serves as a supervisor and subgoal setter of a lower level semi-automatic system which interacts directly with the environment to accomplish a task. Author (TAB)

N67-36767*# Planning Research Corp., Los Angeles, Calif.
SUPERVISORY SYSTEM FOR ON-BOARD CHECKOUT AND DATA MANAGEMENT SYSTEM (OCDMS), SATURN/APOLLO APPLICATION PROGRAM
D. D. Creed and D. H. Stromberg 23 Aug. 1967 89 p refs
(Contract NAS8-20367)
(NASA-CR-88406; PRC-D-1178, Rev. A) CFSTI: HC $3.00/MF $0.65 CSCL 09B

A description is given of the work performed during the third quarter of the research and development program R and D of THE Technologies Required to Design and Fabricate Ultrahigh-Speed Computer Systems. The fabrication and evaluation phases of the 3-, 9-, and 27-bit parity arrays continued. The completed SMX6 and SMX7 high-speed ECL microcircuit gate designs were not fabricated but instead were replaced by two new designs, the SMX8 and SMX9. Author (TAB)

N67-36768# Rome Air Development Center, Griffiss AFB, N. Y.
FREQUENCY PROGRAMMER AND DECODER
Alfred S. Kobos Jun. 1967 42 p refs
(RADC-TR-67-152; DC-64-37; AD-655372)

A technique for encoding 5 information bits into an eight-frequency symbol was implemented and tested. Data at a 62.5 kilobit/second rate is converted into output frequencies each of which is 2 microseconds in duration. Approximately 10 MHz of bandwidth is required for transmission. The performance of this system was determined in the laboratory, using additive gaussian noise for a channel. Error probabilities were measured for the binary data. The experimental results are compared to the theoretical performance of a noncoherent detector for M-ary signals. A brief discussion of the equations used to obtain the theoretical curves is presented. The encoding process is described in detail and the decision process employed is shown to be less efficient than the optimum possible one. The relationship of the binary error rate to the 32-ary symbol error rate is described. Author (TAB)

N67-36770*# Bellcomm, Inc., Washington, D. C.
CONFIGURATION MANAGEMENT OF COMPUTER PROGRAMS
Burt H. Liebowitz 6 Apr. 1967 13 p refs Presented at the 4th Space Congr., Cocoa Beach, Fla., Apr. 1967
(Contract NASw-417)
(NASA-CR-88490) CFSTI: HC $3.00/MF $0.65 CSCL 09B

Proposed is the extension of configuration management procedures which were originally formulated for use in hardware production to the production of computer programs. It is shown that these procedures promote more effective management control by requiring: (1) The development of a two-part computer program specification the first part of which defines the requirements of the program, the second part of which describes the resultant program; (2) Reviews of the design and implementation of the computer program; (3) The control of changes to the specification and the resulting computer program; and (4) The maintenance and updating of the computer program specification and other supporting documents. Author

N67-36774# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
A NUMERICAL INVESTIGATION OF SEVERAL ONE-DIMENSIONAL SEARCH PROCEDURES IN NONLINEAR REGRESSION PROBLEMS
P. D. Flanagan, P. A. Vitale, and J. Mendelsohn Aug. 1967 45 p refs
(RE-300)

The solution of nonlinear regression problems often requires the use of iterative algorithms in order to obtain the best possible set of parameters. It has become apparent that the inclusion of a one-dimensional search procedure between iterations is generally beneficial for improving both convergence and rates of convergence. There are a number of different search procedures currently in use and this report investigates five of them by using the modified Gauss–Newton iterative algorithm with and without second partial derivatives. Four different measures of effectiveness, related to the accuracy and efficiency of the total algorithm, are used to rate the search procedures. Trials on two nonlinear regression problems of three and six parameters show that although a certain degree of accuracy in the search procedure is necessary, an increase in accuracy does not necessarily improve the performance of the total algorithm. Author

N67-36839# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
MIMIC PROGRAMMING MANUAL
Frederick J. Sansom and Harry E. Petersen Jul. 1967 172 p
(SEG-TR-67-31; AD-656301)

The report is intended to serve as a self-teaching and working manual for the MIMIC computer program that provides digital solutions on an IBM 7090(7094) computer for systems of ordinary differential equations. MIMIC is the successor to MIDAS (Modified Integration Digital Analog Simulator). It is considerably more powerful, versatile and efficient while retaining the basic simplicity of its predecessor. The program is intended for a wide range of users, from the engineer with no prior knowledge of digital programming to the sophisticated digital programmer faced with the requirement for obtaining solutions to mathematical problems of this type.

The manual contains complete instructions for reducing the given equations to MIMIC language, handling input and output of data, and detailed explanations - profusely illustrated by examples - of the use of the basic MIMIC functions. Appendices contain a tabulation of all standard MIMIC functions in a compact summary form, five (5) completely solved sample problems, and a description of some aspects of the MIMIC processor. TAB

N67-36855*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A SET OF FORTRAN IV SUBROUTINES FOR GENERATING PRINTED PLOTS
Lois T. Dellner Washington, NASA, Sep. 1967 68 p refs
(NASA-TM-X-1419) CFSTI: HC $3.00/MF $0.65 CSCL 09B

A set of subroutines, written in Fortran IV, easy for the Fortran programmer to use, provides printed plots as part of normal output. These subroutines are simplified so that no choices must be made and generalized so that choices may be made by the programmer of the plotting characters, the scales, the appearance of the grid, and other options. The Fortran routines generate ordinary output records (up to 132 BCD characters) suitable for on- or off-line printing. Author

N67-36858# Philco-Ford Corp., Blue Bell, Pa. Microelectronics Div.
R&D OF THE TECHNOLOGIES REQUIRED TO DESIGN AND FABRICATE ULTRA-HIGH-SPEED COMPUTER SYSTEMS Interim Report, 1 Jan.–31 Mar. 1967
31 Mar. 1967 21 p Prepared for Lincoln Lab., MIT
(Contract AF 19(628)-5167)
(ESD-TR-67-316; IR-11; AD-655804)

A description is given of the work performed during the third quarter of the research and development program 'R and D of the technologies required to design and fabricate ultrahigh-speed computer systems.' The fabrication and evaluation phases of the 3-, 9-, and 27-bit parity arrays continued. The completed SMX6 and SMX7 high-speed ECL microciruit gate designs were not fabricated but instead were replaced by two new designs, the SMX8 and SMX9. Author (TAB)

N67-36894# RAND Corp., Santa Monica, Calif.
NOSY: A CORE-SAVING OPERATING SYSTEM
Ivan L. Finkle and H. L. Scantlin Jul. 1967 11 p
(P-3168/1; AD-655760)

This paper describes an operating system for the IBM 7044 which provides more core storage for the programmer than is available when using the IBM system IBSYS. This is achieved by sacrificing efficiency of input/output; and the system should be used only for programs which cannot run under IBSYS because of core storage requirements. This reflects a drastic change in RANDs computer system: originally an IBM 7040 coupled to a 7044, it now has been reduced to the latter machine. Input and output devices are tape units; tapes are processed by an IBM 360/30. TAB

N67-36902# RAND Corp., Santa Monica, Calif.
PLANET. PART II: BENCH REPAIR SIMULATOR
Bernard J. Voosen and Myron H. Buchanan Apr. 1967 199 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-4660-PR, Pt. II; AD-655769)

The computer routines, operating manual, and programmers manual for the Bench Repair (BR) Simulator, the second of four simulation programs constituting the Planned Logistics Analysis and Evaluation Technique (PLANET). BR is designed to simulate the operations of the various repair shops on an Air Force base. Either one or many shops can be examined with a single simulation. The simulator takes as inputs the shops operating characteristics and simulates shop operation through time. Performance is measured in terms of repair cycle time and the shops capacity. Outputs can be used as an aid in determining the resource requirements necessary to support repair actions. The Bench Repair Simulator can be assembled to the Availability and Base Cadre (ABC) Simulator (PLANET: Part I) to examine problems encompassing all base functions: As BR simulates field level support, ABC simulates the organizational level. Together, the two models incorporate nearly every facet of maintenance and logistics at Air Force bases. TAB

N67-36921# Electro Technical Analysis Corp., Tucson, Ariz.
ANALYSIS OF VECTOR ANALOGUE COMPUTER Final Report
Jun. 1967 130 p refs
(Contract FA-67-WA-1674)
(RD-67-37)

The principles and implementation of the Butler Vector Analog Computer (VAC) are analyzed with emphasis on four concepts: distance proportional filtering, servo loop follow up speed limitations, constant deviation, and VOR receiver rf and af detection improvements. The VAC principles are found to be particularly advantageous when symmetrical VORTAC scalloping exists at frequencies higher than the VAC variable low-pass filtering threshold, (which is a function of amplitude owing to the nonlinear circuit implementation). The mathematical analysis tends to support the Butler research conclusions that a substantial portion of observed VOR scallops can be attributed to spurious receiver response to rf amplitude changes. Author

N67-36951# Kansas Univ., Lawrence. State Geological Survey.
COMPUTER APPLICATIONS IN THE EARTH SCIENCES: COLLOQUIUM ON CLASSIFICATION PROCEDURES
Daniel F. Merriam, ed. 1966 84 p refs Colloq. held in Lawrence, Kans., Dec. 1966 /ts Computer Contrib. 7
(AD-655445)

Current methods of trend analysis utilize mainly the polynomial and Fourier models, both of which are derived from the general linear model. The coefficient matrices associated with the map models are conventionally structured diagonally for polynomials and in blocks for Fourier surfaces. It is possible, however, to consider the elements of such matrices as occupying points in a coefficient space defined by coordinate axes representing the coefficient subscripts. This space may be subdivided in various ways to yield configurations by diagonals, blocks, circles, hyperbolas, etc. Each of these classifications gives rise to a set of ranked map surfaces (sequential or cumulative) that can be used with both map models for expressing and analyzing map data in different ways, and for screening out selected components for map comparisons. Author (TAB)

N67-36999*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A PRODUCTION CONTROL AND ACCOUNTING SYSTEM
Donald E. Jamison Sep. 1967 105 p refs
(NASA-TM-X-55936; X-565-67-467) CSCL 09B

Methods of production control and accounting information storage used at Goddard Space Flight Center were studied. An alternate method of automating many functions of the data handling system is given. Repetitive tasks associated with punched cards

were eliminated and accounting data were consolidated for instant access. The study shows how an IBM 1410 can be used effectively to meet system requirements and still have the capability for expansions. Timing areas were examined to determine how the work load is translated from external physical requirements to machine performed activities. Manual loading times have little effect on the machine. Activities at different terminals are remote from one another and present no loading conflicts. Data movement from input to storage is easy and rapid. Output functions place constraints on the system only in extreme circumstances. Anticipated queuing can be handled by proper scheduling methods and interrupts on a priority basis will seldom be noticed. R.N.A.

N67-37016# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
BATCOST: A COMPUTER CODE FOR PRESENT-WORTH FUEL COST CALCULATIONS
R. F. Burstall 25 Apr. 1967 19 p
(TRG-1489(R)) HMSO: 2s 6d

This report gives a description of the IBM 7090 computer code BATCOST. The code performs calculations of fuel cost using the UK 'present worth' method. Author

N67-37018# Illinois Univ., Urbana. Biological Computer Lab.
THE VISUAL IMAGE PROCESSOR
John K. Russell May 1967 129 p refs
(Contract AF 33(615)-3890; Grant AF-AFOSR-7-67)
(AFOSR-67-1665; TR-11; AD-655842)

An electronic computer which operates on two-dimensional visual images is described. The Visual Image Processor (V.I.P.) is designed to compute on data obtained from image points and their near neighbors. The number of types of computations which can be performed is very large: computation with both digital (quantized) and analog (continuous) signals is possible. The heart of the computer is three cathode-ray electrostatic storage tubes, used as the data storage system. Computation is performed by combining video signals obtained by simultaneously offset-scanning the images recorded in two tubes and writing the outcome of operations performed on the two signals as the newly created image in a third tube. This computing process can be repeated indefinitely if noise considerations are minimized. An algorithm for a possible corner detection scheme is developed to study the variety and kind of operations that arise in parallel computation and which suggests specifications for the V.I.P. Decisions are made in the systems planning and all electronic circuitry used in the V.I.P. are described in detail, as are the tests used to measure its performance. Recommendations are made for further improvement in the performance of the machine. Author (TAB)

N67-37032# Lincoln Lab., Mass. Inst. of Tech., Lexington.
AN ASSOCIATIVE PROCESSING SYSTEM FOR CONVENTIONAL DIGITAL COMPUTERS
Paul D. Rouner and Jerome A. Feldman 21 Apr. 1967 36 p refs
(Contract AF 19(628)-5167; ARPA Order 691)
(ESD-TR-67-242; TR-1967-19; AD-655810)

A user-oriented system having both algebraic and associative processing capabilities is presented in this report. The algebraic capabilities are essentially those of ALGOL. The associative facilities are: (1) A language for the expression of associative retrieval requests (the associative language). (2) A scheme for the internal representation of a store of associations between items of information (an associative information base). (3) Processing routines for associative retrieval requests. The associative language is independent of the structure of the associative information base. In the system presented here, the associative information base is implemented via hash-coding techniques. The associative language is implemented by extending an existing ALGOL system. This report consists of three sections: Sec. I describes the high-level programming language for the overall system; Sec. II outlines the scheme for representing an associative information base; and Sec. III summarizes the processing routines for associative retrieval requests. Author (TAB)

N67-37083* Maryland Univ., College Park. Computer Science Center.
FORMAT: A TEXT PROCESSING PROGRAM
Gerald M. Berns (IBM Washington, D. C.) Jul. 1967 31 p
(Grant NsG-398)
(NASA-CR-88745; TR-67-49) CSCL 09B

The program Format accepts free-form card-image text from any input device supported by OS/360 and produces on any OS/360 supported output device a document in upper and lower case which is formated according to user instructions. These instructions are in the form of control cards and command words which may be interspersed throughout the text input. The user may format his document from among the options, which are communicated to Format via free-form control cards. The command words provide the capability to start a new line, paragraph, column, or page, to tabulate, to underline, to read groups of control cards, to center text on a column-line, to print test from cards, to print text in upper case, and to print text with each word capitalized. The normal output mode is lower case. Means are provided to the user which enable him to specify upper case and special characters. Author

N67-37169# Massachusetts Inst. of Tech., Cambridge.
SOME ASPECTS OF PATTERN RECOGNITION BY COMPUTER
Adolfo Guzman-Arenas (M.S. Thesis) Feb. 1967 127 p refs
(Contract Nonr-4102(01); Proj. Mac)
(MAC-TR-37; AD-656041)

A computer may gather a lot of information from its environment in an optical or graphical manner, if a TV picture of a scene is transformed into a symbolic description of points and lines, or surfaces. This thesis describes several programs, written in the language CONVERT, for analyzing such descriptions in order to recognize, differentiate, and identify desired objects or classes of objects in a scene. Examples are given in each case. Important restrictions and suppositions are: (a) input is assumed perfect (noiseless) and in a symbolic format; (b) no perspective deformation is considered. A portion of this thesis is devoted to the study of models (symbolic representations) of the objects we want to identify, and different schemes, some of them already in use, are discussed. Focusing attention on the more general problem of identifying general objects when they substantially overlap, some schemes are proposed for such recognition, and some concurrent problems are analyzed. Author (TAB)

N67-37221# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
A STANDARD METHOD FOR THE SYNTHESIS OF FINITE AUTOMATA WITHOUT STORAGE, WITH SEVERAL OUTPUTS, CONSTRUCTED FROM STATIC SWITCHING ELEMENTS [O METODA TIP DE SINTEZA A AUTOMATELOR FINITE FARA MEMORIE, CU MAI MULTE IESIRI, REALIZATE CU ELEMENTE DE CONUTATIE STATICA]
S. Basarab 10 Mar. 1967 15 p refs Transl. into ENGLISH from Automatica si Electronica (Bucharest), v. 19, no. 2, 1965 p 76-80
(Contract AF 33(657)-16409)
(FTD-HT-66-484; TT-67-62357; AD-655348)

The article presents an optimal method for the construction of finite memoryless automata with multiple inputs and multiple outputs, starting with static switching elements of the Nor type. Both the principle of the method and its practical application (i.e., the calculations involved) are discussed. TAB

N67-37238# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
A GENERAL PURPOSE VIDEO INPUT DEVICE FOR A DIGITAL COMPUTER Final Technical Report
Theodore R. Strollo and Warren Teitelman 21 Jul. 1967 48 p refs
(Contract Nonr-4758(00))
(BBN-1537; AD-655642)

A general purpose video input device was acquired and interfaced to a digital computer. Time-shared access to this device was provided in real-time. The device was then used to provide input for a hand written character recognition scheme. TAB

N67-37264*# Maryland Univ., College Park. Computer Science Center.
TRANSLATOR AND SIMULATOR FOR THE COMPUTER DESIGN AND SIMULATION PROGRAM (CDSP), VERSION I
Charles K. Mesztenyi May 1967 67 p
(Grant NsG-398)
(NASA-CR-88741; TR-67-48) CSCL 09B

The design of a digital computer or digital device can be described by the Computer Design Language proposed by Y. Chu. This report describes a restricted form of the language in more details for the use of the Computer Design and Simulation Program (CDSP) on IBM 7094. The CDSP consists of an Executive Main program under which various subprograms may be called. This report contains the detailed flow charts of the Translator and Simulator subprograms. The Translator establishes various symbol tables and a Polish string from the description of the designed computer. The Simulator executes test programs written for the designed computer and prints out the contents of prescribed registers. Author

N67-37301*# Planning Research Corp., Los Angeles, Calif.
SUPPORT SYSTEM FOR ON-BOARD CHECKOUT AND DATA MANAGEMENT SYSTEM (OCDMS), SATURN/APOLLO APPLICATION PROGRAM
J. L. Benson and D. H. Stomberg 23 Aug. 1967 74 p
(Contract NAS8-20367)
(NASA-CR-88514; PRC-D-1177, Rev. A) CFSTI: HC $3.00/MF $0.65 CSCL 09B

Requirements for the performance, design, test, and qualification are established for the computer programs for the support system. Details are presented on the functions of language translation; program production, test, and verification; and data, job, and test management. Programming standards and program design are described. Quality assurance provisions for the implementation, integration, and acceptance qualification tests are discussed. N.E.N.

N67-37314 United Kingdom Atomic Energy Authority, Risley, (England). Reactor Group.
SPANDE: A PRELIMINARY GUIDE TO SPACE-FRAME AND PIPEWORK ANALYSIS BY MEANS OF A GENERAL-PURPOSE COMPUTER PROGRAM
D. C. Davies and J. A. Enderby 3 Apr. 1967 44 p refs
(TRG-1409(R)) HMSO: 6s

A general-purpose program for the analysis of three-dimensional frameworks, with additional refinements for pipework systems, is being developed for use on an IBM 7090 computer. The immediate objective is the analysis of structural space-frames and pipework systems by a method which allows a virtually unlimited number of redundancies, but other problems such as the analysis of certain asymmetric shell problems come within its scope. When used for pipework systems, the maximum shear stress in the pipe at each node and at the mid-point of each bend is quoted as part of the output data in addition to the internal forces and moments for each length, the displacements and rotations of each node and the reactions at each point of restraint. The members comprising the system being analysed may be either straight or of constant curvature between nodes, provided that in the case of curved members one of the principal axes of the cross-section of the member lies in the same plane as the member. Any combination of forces, moments or displacements may be imposed at some or all of the nodes. Author

N67-37315# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MEMORY ELEMENT BASED ON A BIAX CORE [ELEMENT PAMYATI NA SERDECHNIKE TIPA "BIAKS"]
Yu. I. Vizun, I. A. Yefimov, and L. G. Tarasov 28 Feb. 1967 6 p Transl. into ENGLISH from Russian Patent No. 164462 (Appl. No. 840436/26-24, 5 Jun. 1963) 2 p
(FTD-HT-67-39/1+2+4)

The report describes a biax core. The output winding is passed through one of the openings of the core. Both the interrogation winding and the recording winding are passed through the other core winding. TAB

N67-37343*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Center.
SPACEBORNE MEMORY ORGANIZATION, AND ASSOCIATIVE DATA ACQUISITION SYSTEM, PHASE II Final Report, Apr.–Dec. 1966
Dale C. Gunderson, Charles Wm. Hastings, and H. Randolph Holt Dec. 1966 139 p refs
(Contract NAS12-38)
(NASA-CR-88001; Rept.-12017-FR2) CFSTI: HC $3.00/MF $0.65 CSCL 09B

A spaceborne data acquisition system is described, based on the use of an associative computer in which each data source is connected to a single word (strand). Its primary functions are multiplexing to provide flexible selection of data sources, analog-to-digital conversion to change analog inputs to digital form suitable for processing and transmission, and data compression to eliminate the redundant data points prior to transmission. System design effort was directed at the array of 256 strands, consisting of a strand memory, strand logic, and a strand input converter; and a microprogram approach to provide control sequence flexibility and logic design simplicity. A general purpose computer is included to serve as a master controller and a program memory for the associative computer. Operating procedures and special applications are discussed. Data compression algorithms, modified to fit the associative computer capabilities, are evaluated. A simulation of this modified approach using real data showed that buffering problems are reduced since a match is allowed between the data acquiring and sending rates of the system. M.G.J.

N67-37397*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SOME APPLICATIONS OF A PROGRAMMING LANGUAGE
Isabella J. Cole and Ellen L. Steinberg Aug. 1967 37 p refs
(NASA-TM-X-55943; X-552-67-367) CFSTI: HC $3.00/MF $0.65 CSCL 09B

A programming language (APL) is specifically designed for applied mathematics. It differs from other programming languages which are commonly used in that it is more concise, precise, and economical of symbols. The APL language is shown for some commonly used transcendental functions. Several improvements of APL are required for such things as program structuring, access to data, presentation of data, i.e., input/output operations and data operations. However, it is felt that some indication is given of the usefulness of APL if one approaches it openmindedly. APL is used for certain applications such as: (1) trigonometric functions and solution of Kepler's equation, (2) harmonic analysis, and (3) matrix operations. The areas of application are chosen primarily for their intrinsic interest to the mission trajectory determination branch and to indicate the usefulness of the language for mission trajectory determination applications. Author

N67-37437# Harry Diamond Labs., Washington, D. C.
CERAMIC MEMORY DEVICE
C. W. H. Barnett Jun. 1967 34 p refs
(HDL-TR-1352; AD-656598)

This is the first report describing HDL development on a ceramic peizoelectric memory. The device is in the form of a disc, 1 in. in diameter and 0.025 in. in thickness containing silver electrodes so placed that it operates as a piezoelectric motor-generator at its resonant frequency. Two stable states, permitting binary coding of information, are realized by utilizing the differing outputs resulting from the presence or absence of remnant polarization between the generator electrodes. It was concluded from voltage time experiments that a write-in voltage of about 1500 V dc applied for 3 sec will induce the one condition (ca. 10 V peak-to-peak) and a subsequent write-in voltage of 1500 V dc of reverse polarity for 3 sec will induce the zero condition (ca. 2-3 V peak-to-peak). The device retains the stored information after a period of time in the no-power condition and the readout is non-destructive. The device has isolated read and write electrodes and requires no internal mechanical switching in its connection to the timer circuits for which it will serve as a memory.
Author (TAB)

N67-37498# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
ANALOG TECHNIQUE FOR OPTIMIZING DYNAMIC SYSTEMS
R. A. Harvey May 1967 15 p ref
(Contract AT(45-1)-1830)
(BNWL-392) CFSTI: HC$3.00/MF$0.65

An iterative analog program has been developed for optimizing a sampled quadratic-like function of an independent parameter. A minimum-seeking sampled dynamic system is discussed with results that show the effects of changing the control loop gain. The program and results for a digital computer implementation using the MIMIC program are presented also. Author (NSA)

N67-37543# Argonne National Lab., Ill.
PERFORMANCE STATISTICS OF THE FORTRAN IV (H) LIBRARY FOR THE IBM SYSTEM/360
N. A. Clark, W. J. Cody, K. E. Hillstrom, and E. A. Thieleker May 1967 38 p
(Contract W-31-109-ENG-38)
(ANL-7321) CFSTI: HC$3.00/MF$0.65

Testing procedures are described and results tabulated for accuracy and timing tests of the basic FORTRAN IV (H) Subroutine Library provided for the IBM System/360 computer. Author

N67-37774*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE USE OF DSL/90 FOR THE SIMULATION OF STABILIZED PLATFORM DYNAMICS
R. A. Lewallen (IBM, Huntsville, Ala.) and H. H. Trauboth 28 Jun. 1967 26 p refs
(NASA-TM-X-53628) CFSTI: HC$3.00/MF$0.65 CSCL 09B

The digital simulation language DSL/90 enables an engineer to write a program closely resembling a block diagram which mathematically describes the continuous dynamics of the system to be simulated. DSL/90 also allows construction of any functional block as a macro using Fortran statements, and unification of macro statements with regular Fortran statements. Six standard integration methods are available to obtain maximum computation speed. The user may also design his own integration scheme. The simulation program is described and results of initial runs are given. Various computation times for the six integration methods were measured for different step sizes and error criteria. The times are presented in tabular form. Among the conclusions it is noted that writing a DSL/90 program requires less programming knowledge than writing a Fortran program. However, some programming experience is necessary, and the program may not always be readily handled by a practical engineer. The program is easier to set up than an analog program, since no scaling, conversion of transfer functions into differential equations, or hardware limitations are met. E.C.

N67-37794# Burroughs Corp., Paoli, Pa. Defense, Space and Special Systems Group.
PLAN FOR DETECTION OF PARALLELISM IN COMPUTER PROGRAMS Quarterly Technical Report, 21 Jan.–21 Apr. 1967
Harvey W. Bingham, David A. Fisher, and John W. Seward Jun. 1967 28 p refs
(Contract DA-28-043-AMC-02463(E))
(TR-67-3; ECOM-02463-3; QPR-3; Rept.-3; AD-655867)

This is the third report of an investigation to determine how implicit parallelism in programs written in compiler languages can be recognized and exploited by machines with highly parallel organizations. The algorithm developed in the two prior reports for detecting the essential order among program parts based upon input-output set intersections and any initially known essential ordering has been applied in this report to loop and array structures. Although parallelism in many array references can be detected, run-time index determination limits the general recognition of array element parallelism. The effects of data structures on parallelism are related to machine organization and memory accessing. The block diagram of a parallelism detection program is given and the source language for programs to be analyzed is described. This program will be used as a tool for the demonstration of the desirability and feasibility for automatic recognition of parallelism in compiler language programs. Levels of program partitioning are discussed. A method for identifying the different instances of a variable during a program and their candidacy as inputs for subsequent references is described. Author (TAB)

N67-37797# Sud-Aviation, Cannes (France). Groupe Technique.
USE OF HYBRID COMPUTING IN SIMULATION [EMPLOI DU CALCUL HYBRIDE EN SIMULATION]
24 Mar. 1966 23 p In FRENCH
(Doc.-51-GTC/57) CFSTI: HC$3.00/MF$0.65

A hybrid computing assembly, combining arithmetical and analog computing, is described. It integrates a universal numerical computer into the simulation sequences composed of analog computers, operating facilities and real rocket piloting and guidance equipment, and makes it possible to do computer work and simulation work alternately, thus ensuring efficient use of the computer facilities. The exchanges of information between analog

computers, arithmetical computers and real equipment are examined and some details given of the form and characteristics of the hybrid liaison unit that provides the conversion, synchronization, and multiplexing of the information. The procedure for using the hybrid computing assembly, i.e. the definition of the sampling modes, the starting-up sequence, and the selection of computing models and programming methods are reviewed, in the course of describing a real-time rocket simulation, using guidance and piloting equipment. Author (ESRO)

N67-37802# Information International, Inc., Cambridge, Mass.
COMPUTER-ASSISTED EXPLANATION: A GUIDE TO EXPLAINING, AND SOME WAYS OF USING A COMPUTER TO ASSIST IN CLEAR EXPLANATION
Edmund C. Berkeley May 1967 287 p refs
(Contract N00014-66-C0281)
(Rept.-8-217/67-60PB; AD-655915)

To explain is to make clear or plain, to change something not understood to something that is understood. This document defines explanation; makes clear the differences between explanation and related subjects; describes and illustrates over 50 factors affecting the quality of an explanation; discusses the classes of words in an explanation and gives a program for vocabulary analysis with a computer; explains methods for revising and improving an explanation and gives three illustrations at length; discusses practical aspects of improved explanation; states in full a powerful Vocabulary Analysis Program which has been worked out and aids explaining (this program runs on the PDP-7 computer of Digital Equipment Corporation, and a copy of the program tape is available on request); states half a dozen more computer programs for aiding explanation; gives eight sample explanations and their assessment; gives an annotated bibliography of 18 references relating to better explanation; and contains a glossary and an index. Author (TAB)

N67-37893*# Oak Ridge National Lab., Tenn.
SUPER-FLICKERS: AN ON-LINE DATA ACQUISITION SYSTEM FOR THE PDP-8
B. W. Rust and W. R. Burrus 1 Jun. 1967 71 p
(NASA Order R-104; Contract W-7405-ENG-26)
(NASA-CR-86897; ORNL-TM-1878) CFSTI: HC $3.00/MF $0.65 CSCL 09B

SUPER-FLICKERS is a system of PDP-8 programs for accumulating and processing 4 parameter data from pulse height and time-of-flight analyzers. It writes all incoming data on magnetic tape for later analysis by a larger computer and provides oscilloscope displays of various 2-dimensional flicker boxes on an event by event basis. It also accumulates and plots certain one dimensional combination spectra which are of interest. Program options are controlled by key switches and plot scaling options are controlled by teletype keys. Author (NSA)

N67-37899# Illinois Univ., Urbana. Dept. of Computer Science.
COMPUTER SYSTEMS HARDWARE RESEARCH AND SOFTWARE SYSTEMS DEVELOPMENT Quarterly Technical Progress Report, Oct.–Dec. 1966
Dec. 1966 217 p refs
(Contract Nonr-1834(15))
(COO-1469-0064; AD-656050)

Contents: Circuit research program; Hardware systems research; Computer system software research; ILLIAC IV; Numerical methods, computer arithmetic and artificial languages; ILLIAC II service use; IBM service, use, and program development; Problem specifications; Switching theory and logical design; General laboratory information. TAB

N67-37934* Oak Ridge National Lab., Tenn. Neutron Physics Div.
A FORTRAN IV/63 PROGRAM PACKAGE FOR CALCULATING THE TIME CHANNEL RESPONSE FUNCTION IN NEUTRON TIME-OF-FLIGHT SPECTROSCOPY
R. T. Santoro 18 Aug. 1967 104 p refs
(NASA Order R-104)
(NASA-CR-88878; ORNL-TM-1836) CSCL 09B

Three computer programs—PTIME, TWALK, and CONVOL—for computing the time-channel response function for a neutron time-of-flight spectrometer are described. PTIME computes the time-jitter smeared physical flight time distribution for the target detector configuration where the incident beam and the detected neutrons are along the cylindrical axes of the target and detector, respectively. The flight time resolution and spectrometer efficiency are computed, and plotted results are provided. TWALK computes the neutron pulse-height spectrum and generates the time-slewing response function with the aid of the time-slewing curve. CONVOL performs the integral over the time-analyzer response function of the convolution of the physical flight time distribution and the time-slewing response function. Instructions on the use of these codes with the CDC-1604 computer are described along with input card formats required for execution. The methods of entabulation and interpolation of graphic data are included. Complete program listings are presented in appendices. Author

N67-38001# RAND Corp., Santa Monica, Calif.
SOVIET CYBERNETICS: RECENT NEWS ITEMS, NO. 6
Wade B. Holland, ed. Jul. 1967 95 p refs
(P-3600/6; AD-655761)

Contents: Brief items; The BESM-3M computer; More on MINSK-222, Novosibirsk computer systems work; Computer design activity in ARMENIA; Kiev management information system; Light pen; Problems in Soviet computer industry; 3 articles for historical perspective; Problems itemized by experts; Dorodnitsyn on the hardware problem; Glushkov on economic cybernetics; RITM computer; Book review: A Report On Computers in Russia; Articles and photographs in the Soviet press, June 1967. TAB

N67-38011 Allgemeine Elektricitats-Gesellschaft, Konstanz (West Germany).
MODERN DATA PROCESSING USING GRAPHIC ILLUSTRATIONS BY DIGITAL COMPUTERS [MODERNE DATENVERARBEITUNG DURCH GRAPHISCHE BILDDARSTELLUNG BEI DIGITALRECHNERN]
[1967] 24 p refs Presented at the Progressive System Tech. Symp., Munich, Jun. 1967

After a brief review on computerized display units, mechanical–graphic and electro-optical procedures for computer data display are described. The technical background and mechanical functions of both systems as well as their visual output are depicted in graphs, symbols, and lines with relation to writing speed, display accuracy, and dynamic behavior. Example displays for both systems are included that pertain to economic and science fields with emphasis on space flight data. Transl. by G.G.

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N67-36685# Bendix Corp., Southfield, Mich. Research Labs. Div.

A TAPERED-LINE 3-DB COUPLER Final Report, Jun. 13–Nov. 13, 1966

C. P. Tresselt Nov. 1966 42 p refs

(Contract N123(62738)56114A)

(Rept.-3772; AD-655655)

The report describes the design and fabrication of a 800-11,000 MHz high-isolation 90 degree coupler employing tapered-line techniques. TAB

N67-36726*# Bendix Corp., Southfield, Mich. Research Labs. Div.

STUDY TO INVESTIGATE THE EFFECTS OF IONIZING RADIATION ON TRANSISTOR SURFACES Final Report

D. L. Nelson, R. J. Sweet, and D. J. Niehaus Jan. 1967 128 p refs

(Contract NAS8-20135)

(NASA-CR-88482; Rept.-3699) CSCL 09A

Ionizing radiation effects, primarily in SiO_2 passivated bipolar transistors, were investigated. Changes in the electrical parameters of irradiated transistors, particularly h_{FE} and I_{CBO}, were studied to determine the physical mechanisms in the surface that produce them. The following devices were also studied to determine the characteristics that produced their various degrees of radiation tolerance: n–p–n and p–n–p bipolar transistors, transistors with commercial and experimental passivation processes, a p-channel MOSFET, and a p-channel junction FET. A nondamaging screening cycle was developed, which permits transistors to be exposed to ionizing radiation for evaluation of their radiation tolerance and then returned to their preirradiation conditions. h_{FE} and I_{CBO} degradations in SiO_2 passivated transistors were demonstrated to be sensitive to bias and to the presence of an ambient gas during irradiation. Two mechanisms of surface degradation are prominent at low injection levels, and a third mechanism is effective at high injection. Buildup of h_{FE} degradation differs in n–p–n and p–n–p SiO_2 passivated planar transistors, with the n–p–n devices generally more radiation-tolerant. None of the three commercial passivation processes investigated (i.e., Fairchild's Planar II, Motorola's Band Guard, and Texas Instruments' Tri Rel) inhibited deleterious effects on h_{FE} and I_{CBO} due to ionizing radiation. A significant discovery was that experimental passivation, in which metallization was laid over the emitter-base junction, significantly reduced h_{FE} degradation and eliminated one of the low level damage mechanisms. Author

N67-36729*# Texas Instruments, Inc., Dallas. Semiconductor-Components Div.

PHOTON-COUPLED ISOLATION SWITCH Quarterly Report, 1 Jan.–31 Mar. 1967

E. L. Bonin 31 Mar. 1967 26 p refs Prepared for JPL

(Contracts NAS7-100; JPL-951340)

(NASA-CR-88506; Rept.-03-67-74; QR-5) CFSTI: HC $3.00/MF $0.65 CSCL 09A

A new integrated circuit switch device, called the photon-coupled isolation switch, is being developed. This device exhibits electrical isolation between the output switch terminals and the driving source by using internal photon generation and detection techniques. The isolation switch consists of a monolithic silicon (Si) integrated circuit, a gallium arsenide (GaAs) photon emitting diode, and a Si phototransistor in a single integrated circuit package. The integrated circuit supplies forward bias for the GaAs diode and, with DTL circuitry, has provision for up to 10 inputs. The GaAs diode is optically coupled to the phototransistor which acts as the electrically isolated output switch. Author

N67-36730*# Watkins-Johnson Co., Palo Alto, Calif.

DEVELOPMENT OF A 100 WATT S-BAND TRAVELING-WAVE TUBE Quarterly Report

L. A. Roberts and M. V. Purnell 9 Aug. 1967 45 p Prepared for JPL

(Contracts NAS7-100; JPL-951299)

(NASA-CR-88505; QR-4) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Continued studies focusing on the development of the WJ-398, a 100 watt, 55% efficiency, 2.3 GHz traveling-wave tube for space applications are reported. Random and sinusoidal vibration performance tests were made on Tube S/N 3 and excellent results were obtained. A two-helix tube was built and tested. Because of internal helix loss problems resulting from constructional difficulties, the tube did not give good electrical performance. A single-helix tube was built operating at a design perveance of 0.80×10^{-6} which gave excellent efficiency results at 66 and 100 watts. Overall efficiency of 45.2% was achieved. This tube also incorporated the new collector design. Author

N67-36733*# Melpar, Inc., Falls Church, Va.

A STUDY FOR THE DETERMINATION OF THE INDENT DEPTH AND CONFIGURATION FOR THE MAXIMUM RELIABILITY CONNECTIONS WHEN NICKEL PLATED COPPER WIRE IS CRIMPED INTO GOLD PLATED CONNECTOR CONTACTS Final Report, 1 Jul. 1966–1 May 1967

May 1967 130 p

(Contract NAS8-20407)

(NASA-CR-88481) CSCL 09A

This study for the determination of indent depth and configuration for maximum reliability connections of nickel-plated copper wire in gold-plated connector contacts prepared and obtained data from over 200 different contact wire combinations. The independent variables were: contact type, contact size, wire size, indent configuration, and indentor spacing. The data were processed and analyzed. The conclusions reached are that the double indent configuration yields significantly greater tensile strength for the NAS and MS contacts than was obtained with a single indent configuration. In addition, the extent of variability of the tensile strength is less for the double indent configuration than for the single indent configuration. The data revealed that crimp contact tensile strength equal to the strength of the wire may be obtained for an optimum double indent indentor spacing. Based upon the derived data for the specified indentor settings, the above conclusion is indicated but is not considered valid for the Bendix Type CE crimped contacts. The data do indicate that the optimum range of indentor settings may be 2.0 to 4.0 thousandths greater for the CE-type contacts than for the NAS and MS types when a double indent configuration is utilized. The study further revealed that: (1) the sample specimens crimped with the double indent configuration yielded less increase in voltage drop as a function of the environmental stressing; (2) the voltage drop characteristics of the Bendix Type CE contacts were not significantly changed by the stress of ten days of salt fog; (3) the voltage drop characteristics of the NAS and MS type contacts were significantly degraded by the exposure to ten days of 1/2 percent salt fog at +50°C; and (4) dimensional changes in any of the contact groups were not considered as being significant. Author

N67-36771* Motorola, Inc., Phoenix, Ariz. Semiconductor Products Div.

ADVANCED TECHNOLOGY OF INTERCONNECTIONS IN MICROELECTRONICS Interim Scientific Report, 16 May 1966–15 May 1967

D. Whitcomb 15 May 1967 54 p

(Contract NAS12-132)

(NASA-CR-85011) CSCL 09A

Standard vacuum evaporation procedures and low energy inert gas sputtering procedures were developed and evaluated for the aluminum, molybdenum–gold, and chromium–gold metallization systems. The residual gas ambient of the high vacuum evaporation was determined. High current density tests were conducted with the aluminum, chromium–gold, and molybdenum–gold metallization systems. The limitations of the chromium–gold metallization system were investigated and as the result, the chromium–gold system is not recommended for use in high reliability integrated circuit technology requiring high temperature processing. The molybdenum–gold metallization system was investigated. The results indicate that the molybdenum–gold system is superior to any other metallization system evaluated to date. Author

N67-36783*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
INVESTIGATION OF SOLDER CRACKING PROBLEMS ON PRINTED CIRCUIT BOARDS
M. J. Berkebile 1 Sep. 1967 25 p
(NASA-TM-X-53653) CFSTI: HC $3.00/MF $0.65 CSCL 09A

A Solder Committee designated to investigate a solder cracking phenomenon occurring on the SATURN electrical/electronic hardware found the cause to be induced stress in the soldered connections rather than faulty soldering techniques. The design of the printed circuit (PC) board assemblies did not allow for thermal expansion of the boards that occurred during normal operation. The difference between the thermal expansion properties of the boards and component lead materials caused stress and cracking in the soldered connections. The failure mechanism and various PC board component mounting configurations are examined. Effective rework techniques using flanged tubelets, copper tubelets, and soft copper wiring are detailed. Future design considerations to provide adequate strain relief in mounting configurations are included to ensure successful solder terminations. Author

N67-36786# United Kingdom Atomic Energy Authority, Culham (England). Research Group.
A FARADAY Q-SWITCH
J. E. Gruber, I. J. Spalding, and S. Ward Mar. 1967 16 p refs
(CLM-R-73) HMSO: 1s 9d

Electro- and magneto-optic Q-switches suitable for use with narrow line-width ruby lasers are briefly reviewed. Experiments on $\pi/2$ and $\pi/4$ Faraday-rotation Q-switches are described, and the operational convenience and merit of these switches is assessed. Author

N67-36849# Varian Associates, San Carlos, Calif. Eimac Div.
DEVELOPMENT OF LINEAR POWER TUBES Interim Development Report, 17 Feb.–16 May 1967
William H. Sain 20 Jun. 1967 55 p
(Contract N00024-67-C-1044)
(AD-655291)

UHF tetrode (oxide cathode) designs were optimized to achieve the required intermodulation distortion product ratios of -45 db, or better, third and fifth order, with minimum idling current and with better than 50 per cent plate circuit efficiency. Further information was obtained on the relationships between tube geometry and linearity performance. The range of idling current for optimum linear performance has been defined for two different tube geometries. Experiments were performed in a continuously pumped vacuum system on a moveable electrode planar model approximation of a (Th-W filamentary emitter) cylindrical tetrode. Intermodulation distortion evaluations were conducted and are reported as a function of electrode geometry. The audio frequency measurement techniques which were employed gave results substantially in agreement with 2 Mc measurements. Author (TAB)

N67-36851*# Varian Associates, San Carlos, Calif. Eimac Div.
ESFK 20–100 WATT S-BAND AMPLIFIER Quarterly Report
Erling L. Lien and Albert Mizuhara Jul. 1967 19 p Prepared for JPL
(Contracts NAS7-100; JPL-951105)
(NASA-CR-88520; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 09A

A beam-analyzer chamber experiment is described in which beam diameter measurements were made on the RF bunched beam of the X-3064 number 3S klystron. This klystron, when placed in the chamber, was complete except for the output resonator and collector. A pin-hole target was used to measure the beam size by scanning across the beam in the region normally occupied by the output cavity. The results show conclusively that most of the beam interception occurs in the output resonator tunnel. A description of the suppressor lens and collector entrance modification is also given. The design changes were based both on the beam analyzer trajectory measurements and the computer solutions to the field distribution in the suppressor lens. The analysis showed that a larger suppressor lens diameter and collector entrance are necessary. A brief discussion of the fabrication of tube number 3SR is also included, with particular emphasis on the output resonator cold test data. Author

N67-36867* Chrysler Corp., New Orleans, La. Space Div.
PRESSURE SWITCH, CUSTOM COMPONENT SWITCHES, INC., PART NUMBERS 8G426-1 AND 8G426-5, NASA DRAWING NUMBERS 10344443-6 AND 10434443-18 Test Report
C. L. Foy 20 Jun. 1967 51 p
(Contract NAS8-4016)
(NASA-CR-88626; TR-RE-CCSD-FO-1127-3)

This report presents the results of tests performed on 3 pressure switches. The following tests were performed: 1) receiving inspection, 2) proof pressure, 3) functional, 4) low temperature, 5) high temperature, 6) vibration, 7) humidity, 8) salt fog, 9) explosion, and 10) cycle. The results of the tests were satisfactory and the performance of the test specimens was in accordance with specification requirements. Author

N67-36875# Hughes Aircraft Co., Fullerton, Calif.
HANDBOOK OF DESIGN CRITERIA FOR MICROELECTRONIC SYSTEM PACKAGES. VOLUME IIIa: DESIGN DATA Final Report, Nov. 1965–Jan. 1967
Michael A. Merrigan Griffiss AFB, N. Y., RADC, May 1967 183 p refs
(Contract AF 30(602)-3934)
(RADC-TR-67-125, Vol. IIIa; AD-655763)

The volume contains design data for reference as a means of assisting the program manager and equipment designer in implementing the procedures described in Volume II (AD-655 762). These data includes general guidelines for accomplishing tasks and tabulated information to assist in making decisions during implementation of the procedures. Author (TAB)

N67-36891# Watkins-Johnson Co., Palo Alto, Calif.
INVESTIGATION OF LOW WEIGHT FOCUSING SCHEMES FOR TRAVELING-WAVE TUBE AMPLIFIERS Quarterly Report, 15 Jan.–14 Apr. 1967
J. N. Nelson 12 May 1967 28 p
(Contract DA-28-043-AMC-02578(E))
(RCS-OSD-1366; ECOM-02578-3; QR-3; AD-655272)

The report describes the third quarter results on a program concerned with the investigation of lightweight focusing schemes for low-noise TWT amplifiers. These results are of significance because they represent an advance in low-noise, X-band TWT technology and show some important effects of reversed-field focusing on solid and hollow beams. The results show that a noise figure less than 6.0 dB, a gain greater than 30 dB, and an output power greater than 10 mW can be achieved at X-band frequencies with a solid-beam tube focused in a lightweight, 3.4 pound, single-reversal permanent magnet. The results also show that a noise figure less than 5.0 dB, a gain greater than 20 dB, and a power output greater than 0.5 mW can be achieved at X-band with a lightweight, 6.4 pound, straight-field permanent magnet. A high magnetic field is necessary to achieve lowest noise performance in a SRPM. Unfortunately, this causes velocity spread effects which seriously degrade the gain and power output of the tube. The best means for minimizing the velocity spread without increasing the noise figure is to employ a low gamma a, high voltage helix design. A low voltage, low current density, hollow-beam tube gives lower noise figure than higher voltage solid-beam tubes. However, a hollow beam collapses when it passes through a sudden field reversal. This causes a drastic fall off in gain and power. The utility of a low noise, hollow beam SRPM tube awaits evaluation of a severed helix design which incorporates a high gamma a input helix and a low gamma a output helix. Author (TAB)

N67-36907# Zenith Radio Research Corp., Menlo Park, Calif.
TRANSVERSE-WAVE HIGH-POWER TUBE Quarterly Report, 1 Jan.–31 Mar. 1967
C. Burton Crumly and Roy A. Larsen Jun. 1967 21 p
(Contract DA-AB07-67-C-0226)
(ECOM-0226-1; QR-1; AD-656624)

Research and development work is described on a traveling-wave power amplifier tube employing transverse-wave interaction between the negative synchronous wave and a circuit wave on a balanced structure. The theoretical advantage in this arrangement is the possibility of high-power amplification with high overall efficiency, due to the lack of longitudinal or transverse velocity modulation in the spent beam. Important aspects of output power and gun design are reviewed. Attenuator studies are detailed along with fabrication techniques and test results. All component parts have been completed and assembly of the first tube has begun. Author (TAB)

N67-36910# Army Electronics Labs., Fort Monmouth, N. J. Communications/ADP Lab.
HIGH-EFFICIENCY TRANSISTOR CW RF POWER AMPLIFIER
Dieter R. Lohrmann May 1967 50 p refs
(ECOM-2836; AD-656740)

Research work on VHF transistor power amplifiers of the switched type demonstrates semi broadband designs yielding collector efficiencies as high as 80% at 40W output in the frequency range from 30 to 76 MHz. A laboratory model of such an amplifier was built. It was designed to fit the AN/VRC-12. Author (TAB)

N67-36920*# Mallory (P. R.) and Co., Inc., Burlington, Mass. Lab. for Physical Science.
INTERCONNECTION AND ENCAPSULATION OF INTEGRATED CIRCUITS BY ANODIC BONDING Final Technical Report, 1 Jul. 1966–31 Mar. 1967
31 Mar. 1967 60 p
(Contract NAS12-142)
(NASA-CR-85026) CSCL 09A

An attempt was made to apply the Mallory proprietary bonding method to the encapsulation and interconnection of metallized silicon planar junctions via the flip chip approach. Planar diodes are provided with metallization consisting of 5 mil wide lines terminating in a pad on each end. One pad contacts the diffused silicon and the other is positioned on the planar oxide. A sheet of glass with a matching metallization pattern is bonded to the silicon diodes so that the critical junction regions are hermetically covered by the glass and the metallizations on the glass and the diodes are aligned so that the diffused silicon regions may be electrically contacted by means of the metal pads on the glass. Bonding is accomplished at low temperature. No fluxes, adhesives, or intermediary materials are required and metals and glass remain solid throughout the bonding procedure. Author

N67-36927*# Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.
INVESTIGATION TO IMPROVE VACUUM EVAPORATED THIN FILM RESISTORS Final Report, 14 Apr. 1965–13 Dec. 1966
R. B. Belser and M. D. Carithers 1967 141 p refs
(Contract NAS8-20072)
(NASA-CR-88468)

Research was conducted to develop a stable thin film resistor material of high resistivity, low temperature coefficient of resistance (TCR), and reproducibly depositable by vacuum evaporation methods. Films of the classes metal, metal–metal oxide, metal–silicon monoxide, metal nitrides, silicides, and borides were prepared and examined for electrical and structural properties. From the standpoint of high resistivity, low TCR, and stability, Cr+SiO was the most desirable material. Zirconium–zirconium oxide yielded about 2500 microhm-cm with low TCR but poorer aging qualities. $CrSi_2$ and $CrSi_2$+$TiSi_2$ yielded resistivities of about 1600 and 3600 microhm-cm, respectively, with low TCR and good stability. There was difficulty with Cr+SiO in controlling its co-evaporation with single or dual source arrangements. Uniformity of substrate heating was an additional variable affecting uniformity of film resistivity over large glass surfaces. $CrSi_2$ shows excellent stability and can be evaporated from a single source to produce films of higher resistivity than some metal films now being used. R.N.A.

N67-36980# General Electric Co., Syracuse, N. Y. Heavy Military Electronics Dept.
MUTUAL COUPLING STUDY
George F. Farrell, Jr. 31 Mar. 1967 60 p refs Prepared for Lincoln Lab., MIT
(Contract AF 19(628)-5167; ARPA Order 498)
(ESD-TR-67-279; AD-655800)

The report gives the complete derivation (in an appendix) of the radiation admittance of a rectangular waveguide acting as an element in an infinite phased array. The derived equations are capable of predicting the experimentally observed anomalous notch that has been found to exist in arrays composed of large waveguides. The defining equations demonstrate that it is the existence of nonpropagating higher order modes inside the element waveguides that determine the behavior of an infinite array. It was the purpose of this study to determine what waveguide modes were important for a reasonably confident prediction of the radiation admittance of a rectangular waveguide in an array. It is shown that the number of modes needed for this is not excessively great, but that more are needed if it is desired to predict the position of an anomalous notch with any great degree of confidence. Author (TAB)

N67-36987* Boeing Co., New Orleans, La. Launch Systems Branch.
POST FOAM EXPANSION IN S-IC ELECTRICAL DISTRIBUTORS
Robert O. Koch [1967] 111 p
(Contract NAS8-5608)
(NASA-CR-88511; T5-6556-13, Vol. I) CSCL 09A

This study was initiated because of several incidences of post expansion of BMS 8-38, Type I, Gr. "FR" foam in S-IC electrical distributors. Tests on laboratory specimens confirmed that the foam, when processed per 60B32016 and cured at room temperature, does possess post expansion potential when subjected to subsequent elevated temperatures of 150° to 195°F (lower temperatures were not elevated). But, tests also showed that processing the foam at recommended elevated temperatures will produce a foam that is dimensionally stable up to 180°F. Post foam expansion, forced by heating assembled distributors at 180°F, caused no malfunctions or electrical discontinuities. With respect to already fabricated distributors, tests showed that: (1) forcing post foam expansion by heating in an oven under controlled conditions will minimize additional expansion and (2) that proper trimming of the foam surfaces will minimize deflection of the terminal boards and reduce the possibility of foam contact of the p.c. cards and union switch relays. Author

N67-37010* Chrysler Corp., New Orleans, La. Space Div.
PRESSURE SWITCH, HELICOID GAGE DIVISION PART NUMBERS 4231-1 AND 4231-2, NASA DRAWING NUMBERS 10434443-18 AND 10434443-6 Test Report
C. L. Foy 11 Jul. 1967 65 p
(Contract NAS8-4016)
(NASA-CR-88623; TR-RE-CCSD-FO-1128-3) CSCL 09A

The results of environmental and function tests performed on three specimens of pressure switch 10434443 are presented. Specimen 1 would not actuate during the function test, its set pressure dial pointer and blowout disc came loose at 25 cps during the Y-axis sinusoidal search, and at 40 cps the plexiglas lens rotated, the nameplate loosened, and the Mirco Switch contact arm bent downward. It also bottomed at each frequency. A crack occurred in the capillary tubing of specimen 2 during the X-axis vibration tests making it inoperative. Shock mounts of all specimens were gouged and cut after the vibration tests. The contact voltage drop of specimen 2 was out of tolerance after the humidity test. The differential pressure of specimen 3 exceeded the specified limit after the salt fog test, and its set pressure dial pointer came loose at 40 cps during the Z-axis sine sweep. The actuation pressure of specimen 2 was outside the specified limits after the Z-axis sinusoidal sweep during the vibration retest, and its Micro Switch operated intermittently between 79 and 84 psig during the cycle test. Author

N67-37014# Hughes Aircraft Co., Los Angeles, Calif. Electron Dynamics Div.
DEVELOPMENT OF TRANSMITTER TUBE FOR TROPOSCATTER APPLICATIONS Triannual Report, 1 Oct. 1966-31 Jan. 1967
Thomas B. Brown, Otto G. Sauseng, Gorden A. Lange, and J. C. Dixon Apr. 1967 54 p refs
(Contract DA-043-AMC-02316(E))
(RCS-OSD-1366; W-2275; ECOM-02316-2; Rept.-2; AD-655277)

The program objective is to determine the design criteria for a highly efficient (50% overall including focusing and cooling power) 10 kW CW traveling-wave amplifier at C-band and to demonstrate a feasibility model of the device. This amplifier is to have 11 dB of gain to boost the output of existing 1 kW troposcatter systems using power generators readily available. Techniques to improve the efficiency by reducing the power necessary to cool the device are an integral part of the program. Improvement in basic tube efficiency is to be accomplished by voltage jump tapering -- a recently developed technique which has demonstrated over 60% efficiency in an experimental traveling-wave amplifier. Cooling efficiency will be improved by utilizing vapor phase (nucleate boiling) cooling, eliminating the need for a coolant pump. Author (TAB)

N67-37104# Army Electronics Labs., Fort Monmouth, N. J. Electronic Components Lab.
MODERN VHF FILTER CRYSTALS
Theodore J. Lukaszek, Arthur D. Ballato, and Heinz Wasshausen Apr. 1967 34 p refs
(ECOM-2813; AD-655532)

With the advent of the trapped energy theory and experiments in which the electrode thickness was incorporated as an additional design criterion, design data are now available which permits the production of VHF filter crystals with a wide range of equivalent electric circuit parameters. It has been shown that in order to achieve consistent results when employing this technique, two factors must be rigorously adhered to: (1) a high degree of accuracy must be maintained in the plating operation and (2) deviation from plate parallelism must be held to a minimum. The necessity of developing modern filter crystals in the VHF range is well dramatized in Figure 17 by showing the extent to which the crystal filter capabilities have been extended. In addition to the benefits which are obtained in the suppression of unwanted modes there is some indication that crystal Q can also be improved. Since the number of crystals measured possessing extremely parallel surfaces was limited, this data should not be taken as conclusive, but only to open the door to additional investigations of crystal Q-plate parallelism correlation. Author (TAB)

N67-37118# Hughes Aircraft Co., Fullerton, Calif.
HANDBOOK OF DESIGN CRITERIA FOR MICROELECTRONIC SYSTEM PACKAGES. VOLUME IV: DESIGN EXAMPLE Final Report, Nov. 1965-Jan. 1967
Michael A. Merrigan Griffiss AFB, N. Y., RADC, May 1967 67 p
(Contract AF 30(602)-3934)
(RADC-TR-67-125, Vol. IV; AD-655765) CFSTI: HC $3.00/MF $0.65

The volume illustrates the use of the procedures and design data contained in the handbook by utilizing them to guide solution of a sample design problem. In this problem, the packaging design of an existing electronic equipment is revised to achieve more appropriately compliance with a new set of design requirements. This section may also be referenced as an aid in understanding the procedures defined in Volume II (AD-655762). Author (TAB)

N67-37280# Microwave Electronics Corp., Palo Alto, Calif.
PULSED MAGNETIC FIELD FERROMAGNETIC MICROWAVE GENERATOR Quarterly Progress Report, 1 Jan.-31 Mar. 1967
L. D. Buchmiller and F. A. Olson Fort Monmouth, N. J., Army Electron. Labs., Aug. 1967 29 p refs
(Contract DA AB07-67-C-0215)
(ECOM-0215-1; QPR-1; AD-656473)

Operating experience has been obtained with the Stanford Model II-B pulsed ferrite X-band generator. Preliminary pulser tests were performed with a commercially available voltage-triggered spark gap switch. A pulse rise time of one nanosecond at 10 kV was obtained at a pulse repetition frequency of 1000 Hz. Author (TAB)

N67-37287# Michigan Univ., Ann Arbor. Electron Physics Lab.
STUDY OF CROSSED-FIELD ELECTRON DEVICES Semiannual Progress Report, 26 Oct.–15 Mar. 1967
N. A. Masnari, K. F. Morman, J. E. Rowe, and A. Singh Jun. 1967 42 p refs
(Contract DAAB07-67-C-0093)
(ECOM-0093-1; SAPR-1; AD-655509)

The crossed-field noise investigations are concerned with the generation of noise and the characteristics of the beam during the transient interval. The propagation of velocity and current fluctuations along the beam is considered for various regions of a crossed-field device. The formulation of an adequate coupled-mode theory for the gun region has been considered. Velocity-jump noise transformers are considered for use in relatively high-power crossed-field amplifiers. The vacuum system for the crossed-field amplifier has been completely renovated and initial testing indicates that pressures of 5 x 10 to the minus 8th power Torr can be achieved during cathode activation. The abbreviated Kino gun is being tested in the beam analyzer. The aperture-deflection plate system for monitoring current density and velocity of electrons has been located at the exit plane of the gun. Initial investigations indicate that the system in general performs in the desired manner. More detailed investigations are needed to evaluate the accuracy of the system. Author (TAB)

N67-37329# Andrew Corp., Chicago, Ill.
RESEARCH AND DEVELOPMENT OF HIGH TEMPERATURE, HIGH POWER, RADIO FREQUENCY, TRANSMISSION LINES FOR 350°C AND 825°C
H. L. Woodbury [1963] 43 p refs Presented at 11th Ann. Symp. on Communic., Wires and Cables
(Contract AF 33(616)-7389)
(AD-656068)

The paper will describe the development of two high temperature, low-loss, coaxial cables for operation in the -65 to 350C and -100 to 825C temperature ranges. These cables were developed primarily for use on aircraft, missiles and space vehicles. The high temperature requirements exist because the cable path may lead from the relatively cool areas of cockpit environments to the extremely hot external surfaces of a vehicle. TAB

N67-37332*# Goodyear Aerospace Corp., Akron, Ohio.
MICROELECTRONICS EVALUATION. PULSE WIDTH MODULATOR AND POWER DRIVER
1 May 1967 83 p
(Contract NAS8-20205)
(GER-12189S8; IR-9) CFSTI: HC $3.00/MF $0.65 CSCL 09A

The test procedures used to evaluate the pulse width modulator (PWM) and power driver portions of the amplifier are described, and the results of tests performed on prototype integrated circuits are reported. Although several types of PWM's were tested, the integrated version was of prime concern. Tests on the two sections include both static and dynamic tests. The static tests were performed with the Tektronix 575 Transistor Curve Tracer. Dynamic testing included individual functional tests and functional tests of the combined amplifier at three ambient temperatures. Individual amplifier components were evaluated prior to constructing an integrated version of the PWM and finalizing the design of the power driver. PWM design approaches included the use of all NPN transistors, the use of PNP transistors for the NAND function, and the use of available integrated circuits with discrete components. Several preliminary designs of the power driver were tested. Author

N67-37338 Lockheed Missiles and Space Co., Sunnyvale, Calif. Electronics Div.
RADIAL LINE STUBS AS ELEMENTS IN STRIPLINE CIRCUITS
Jorgen P. Vinding [1966] 14 p refs
(LMSC-808981)

The discussion shows that radial line stubs are attractive as shunt elements in strip line circuits because very low input impedance can be obtained over a large frequency range and with a well defined point of contact. This well defined point of contact also prevents excitation of transverse modes which could be supported in some part of the stub. To illustrate the use of such stubs, a low pass filter with a cut-off frequency of 3.54 GHz has been designed with uniform line series elements and radial line shunt elements. The filter shows essentially the predicted pass band characteristic, but the stop band has been displaced towards lower frequencies and a spurious response is found around 8.8 GHz. The displacement is found to be caused by fringing capacitance at the end of each stub and the spurious response is believed to be due to insufficient ground plane interconnection. Author

N67-37393# Sigmatron, Inc., Goleta, Calif.
DEVELOPMENT OF THIN FILM ELECTROLUMINESCENT DISPLAY TECHNIQUES Final Report, 15 Mar.–15 Sep. 1966
E. J. Soxman Wright-Patterson AFB, Ohio, AMRL, Apr. 1967 38 p refs
(Contract AF 33(615)-3644)
(AMRL-TR-67-1; AD-655903)

An electroluminescent display panel of the cross-grid-matrix-type was fabricated on a 10-3/4 x 10-3/4-inch glass substrate using improved vacuum deposition procedures and a high brightness manganese-doped ZnS phosphor. This panel contained 256 x 256 active elements within an area of approximately 7 x 7 inches. Linear resolution was 36 elements per inch with a cross-conductor width of 0.020 inch and a separation of 0.007 inch. The display panel was successfully used as a viewing screen for rear-projected images. The brightness-voltage relationship of the thin film phosphor was such that a cross-suppression ratio in excess of 10,000 to 1 was achieved with an excited element brightness of 100 ft-L. Performance measurements indicated that the optimum drive frequency was about 15 kHz. For pulsed operation, a burst frequency of 37.5 Hz, a carrier frequency of 15 kHz, and a duty cycle of 0.25 percent gave an average brightness of a few foot-Lamberts. Useful operating lifetime of several hundred hours under the above conditions was indicated by preliminary data. The variation in brightness uniformity over a group of cells near the center of the panel was less than 7 percent at an average brightness level of 16 ft-L. A brightness reduction of about 12 percent was observed at a single cell when the contacting configuration was varied on the stannic oxide electrode. Author (TAB)

N67-37448# Hughes Aircraft Co., Fullerton, Calif.
HANDBOOK OF DESIGN CRITERIA FOR MICROELECTRONIC SYSTEM PACKAGES. VOLUME IIIb: DESIGN DATA Final Report, Nov. 1965–Jan. 1967
Michael A. Merrigan Griffiss AFB, N. Y., RADC, May 1967 384 p refs
(Contract AF 30(602)-3934)
(RADC-TR-67-125, Vol. IIIb; AD-655764)

The volume contains design data for reference as a means of assisting the program manager and equipment designer in implementing the procedures described in Volume II. These data include general guidelines for accomplishing tasks and tabulated information to assist in making decisions during implementation of the procedures. Author (TAB)

N67-37469# National Bureau of Standards, Washington, D. C.
COLORS OF SIGNAL LIGHTS: THEIR SELECTION, DEFINITION, MEASUREMENT, PRODUCTION, AND USE
F. C. Breckenridge 3 Apr. 1967 59 p refs
(NBS-MONO-75)

This monograph is intended to serve as a reference work for all those concerned with the selection, specifications, and use of signal-light colors. It discusses the nature of the problem, and the mathematical representation, recognition, production, control, and use of such colors. The characteristics of different types of chromaticity boundaries and the purpose and effect of the requirement for similarity of chromaticity characteristics are given special consideration. The treatment is varied according to the intended use. The discussion of the control of colors and the section on the use of colors are nontechnical, whereas the section on the production of signal colors is designed for the colorimetrist who is faced with the problem of selecting limit filters or drafting a specification. Author

N67-37473# Army Electronics Labs., Fort Monmouth, N. J. Electron Tubes Div.
EVALUATION TESTS OF A LOW-SINTER-TEMPERATURE, CERAMIC METALIZING PROCESS
Stanley R. Du Buske May 1967 20 p refs
(ECOM-2851; AD-656460)

A series of evaluation tests were made of a low-sinter-temperature, refractory-metal-oxides (MoO3/MnO2) ceramic metalizing suspension. The tests were made to determine what limitations, if any, exist for the application of the low-sinter-temperature (900C to 1100C) metalizing suspension for electron-tube fabrication. The metalizing suspension was found to be easy to handle, especially since ordinary brazing furnaces rather than special high-temperature sinter furnaces can be used for the sintering process. In addition, no overplating of the sintered-metalized ceramic surfaces was needed to produce high-strength, hermetic seals. The highest tensile strength, most reliable ceramic-to-ceramic and ceramic-to-metal seals were obtained when the maximum sinter temperature of 1100C was used in conjunction with the vacuum-tube grade solders OFHC copper, nickel-gold eutectic, and gold-copper eutectic. Author (TAB)

N67-37547# Lincoln Lab., Mass. Inst. of Tech., Lexington.
PROJECT MAPOLE (MAGNETIC DIPOLE SPARK TRANSMITTER)
Marcel P. Fraser 22 May 1967 42 p refs
(Contract AF 19(628)-5167)
(TN-1967-24; ESD-TR-67-265; AD-656706)

The report describes theoretical and experimental work on the development of a VHF high-power closed-ring spark transmitter, a device theoretically capable of producing gigawatt peak powers in the nanosecond pulse-length region. The investigation and the report were conveniently divided into three distinct, though interrelated, categories: First, the theoretical aspects of transmitter performance; second, an investigation of certain aspects of spark-gap performance germane to the entire undertaking; finally, the construction and experimental evaluation of the complete transmitter. Author (TAB)

N67-37664# International Business Machines Corp., Hopewell Junction, N. Y. Components Div.
MATHEMATICAL INVESTIGATIONS OF SEMICONDUCTOR DEVICES Final Report, Apr. 1, 1966–Apr. 1, 1967
D. P. Kennedy Apr. 1967 134 p refs
(Contract AF 19(628)-5072)
(AFCRL-66-358(II); AD-655803)

The report covers a mathematical analysis of the mechanisms of operation with a Small Current Amplifying Device (SCAD). The analysis is in two spatial variables and includes the mixed boundary conditions encountered in a practical semiconductor device. Computer calculated distributions are graphically illustrated to show the space-charge and voltage drop within a source-drain channel, at equilibrium and also throughout a range of biasing conditions. Included in this report is a detailed one-dimensional analysis of the linearly-graded p-n junction. This analysis discusses several modes of operation not characterized by the depletion layer theory: for example, forward bias and reverse bias collector junction operation. A detailed comparison is presented between the results of this rigorous computational investigation, and the results obtained by other authors using more approximate methods of mathematical analysis. Author (TAB)

N67-37697# Electrotechnical Lab., Tokyo (Japan).
SOME FUNDAMENTAL ASPECTS ON THE DESIGN OF POWER THYRISTORS. PART 1. VOLTAGE BLOCKING CAPABILITY
Toshio Tsurushima and Mitsuo Kawashima Jan. 1967 70 p refs In JAPANESE; ENGLISH summary *Its* Circulars of the Electrotech. Lab. No. 160

Basic understandings of silicon thyristors are reviewed, with emphasis on internal physics and design criteria for high power devices. Voltage blocking capabilities of thyristors and breakdown phenomena in p–n junctions are discussed, and data for maximum blocking voltage of thyristors and avalanche breakdown voltage for p–n junctions are included. Some dynamic properties of thyristors are presented, and the relationship of carrier injection and extraction dynamics to switching speed is reviewed. Carrier recombination under heavy injected conditions as well as lifetime control by deep level impurities are described; and some factors related to current carrying capacities and to the heat generation mechanism and temperature rise in silicon thyristors are noted. An extensive bibliography in English is included. M.W.R.

N67-37719# Sandia Corp., Albuquerque, N. Mex.
TRACK SWITCH/MINUS TWO RELAY BOX
Stephen Farrelly May 1967 9 p
(Contract AT(29-1)-789)
(SC-TM-67-290) CFSTI: HC $3.00/MF $0.65

A track switch/minus two relay box is described which is part of a system to actuate cameras covering the Area III sled tracks. The box combines a 110V ac switch closure side and a 28V dc switch closure and circuit break side. Author (NSA)

N67-37964# Technische Hochschule Carolo Wilhelmina, Brunswick (West Germany).
THE PERFORMANCE OF A PASSIVE CROWBAR-SYSTEM [DIE ENTWICKLUNG EINES KURZSCHLIESSERFUNKEN-STRECKEN-SYSTEMS]
W. Breuer, I. Christou, and W. Koch Apr. 1967 21 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-34)

A spark-gap-device for passive crowbar operation is constructed which can be connected exactly at zero voltage of a ringing discharge. The operating principles of such multi-electrode arrangements at atmospheric pressure are discussed. Experimental work has been undertaken to complete the development of a special trigger generator for 48 crowbar gaps in parallel operation. It was necessary to investigate the problems posed by the parallel working of many such devices. The most serious problem is the prefiring of one crowbar gap at the start of the main discharge since the current in the falling group will raise to a high value. It is possible to overcome these problems by variation of the technical data. The development of the crowbar system for the 1.2 MJ battery project at Jülich has been completed. Author (NSA)

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N67-36706* Farnham (Frank C.) Co., Philadelphia, Pa.
CALCULATION OF A SAWTOOTH-VOLTAGE-OSCILLATION SHAPING CIRCUIT [K RASCHETU KONTURA FORMIRO-PILOOBRAZNYKH KOLEBANNIY NAPRYAZHENIYA]
Ye. M. Reshetnikov and V. P. Klimov Washington, NASA, Sep. 1967 11 p refs Transl. into ENGLISH from Elektromekhan. (USSR), no. 3, 1967 p 295–302
(Contract NASw-1497)
(NASA-TT-F-11230) CSCL 09C

Theoretical analysis is made of the synthesis of sawtooth voltage oscillations of triangular shape for pulse-width modulation pulse shapers. An expression is obtained for the relation between the amplitudes of the desired triangular oscillations and the square pulses entering the input of the integrating circuit. The effect of the parameters of the sawtooth-oscillation shaping circuit on the linear output characteristic of a pulse-width modulation pulse shaper is ascertained, as well as the deviation of the off-duty factor of a real pulse-width modulation pulse shaper from the ideal off-duty factor. Author

N67-36781# Polytechnic Inst. of Brooklyn, N. Y.
INCLUSION—PROBABILITY—OPTIMAL CONTROL
Leo J. Van Mellaert 25 May 1967 89 p refs
(Contract AF 49(638)-1402)
(PIBMRI-1364-67; AFOSR-67-1229; AD-655387)

A multi-dimensional stochastic dynamical system is considered. The system can be nonlinear and time-varying. It is assumed that the state of this system can be measured noisefree at all times. An optimal control policy is formulated leading to the maximization of the probability of constraining the trajectory of the system to a certain subregion of the state-space over a finite period of time. On the basis of dynamic programming an optimization equation is derived. This equation is a quasilinear second order parabolic partial differential equation. The equation is solved on a digital computer. The numerical technique appears to be highly efficient in speed and memory requirements. Examples are included for first and second order dynamical systems. Author (TAB)

N67-36841# Scope, Inc., Falls Church, Va.
INFORMATION THEORY, LEARNING SYSTEMS AND SELF-ORGANIZING CONTROL SYSTEMS Final Report
Malcolm Rucj Uffelman 31 Mar. 1967 51 p refs
(Contract Nonr-4467(00))
(AD-656082)

Learning systems are defined on three levels of complexity, the trained system, the adaptive system, and the self-organizing system. The functional purpose of each is discussed in terms of the removal of noise and a theorem stating a necessary condition for adaption is stated and proven. The theorem is then applied to a simple form of adaptive system, and it is shown that for a linear threshold device employed within its natural capacity, two bits per weight are necessary. The information theoretic model of the self-organizing system is translated into a goal directed control system model. This self-organizing control system model is analyzed and shown to have a simple performance surface that can be searched by relaxation methods. Experiments are discussed. Author (TAB)

N67-36859 Royal Aircraft Establishment, Farnborough (England).
LINEAR CIRCUIT ANALYSIS BY MEANS OF A DIGITAL COMPUTER
C. C. Cradwick Jan. 1967 28 p refs
(RAE-TR-67012)

Only quite simple electronic circuits can normally be analyzed exactly by manual means, due to the labor involved in solving the circuit equations. An introduction to the use of a digital computer to overcome this problem is presented. A general purpose program is described which will analyze linear circuits, containing both passive and active elements, of up to 50 nodes, and the underlying circuit analysis is discussed in some detail. Authrv

N67-36979# California Univ., Berkeley. Operations Research Center.
L-SHAPED LINEAR PROGRAMS WITH APPLICATIONS TO OPTIMAL CONTROL AND STOCHASTIC PROGRAMMING
R. M. Van Slyke and Roger J.-B. Wets (Boeing Sci. Res. Labs.) Jun. 1967 47 p refs Revised
(Contract Nonr-222(83); Grant NSF GP-4593)
(ORC-66-17; AD-656045)

The paper gives an algorithm for L-shaped linear programs which arise naturally in optimal control problems with state constraints and stochastic linear programs (which can be represented in this form with an infinite number of linear constraints). The first section describes a cutting hyperplane algorithm which is shown to be equivalent to a partial decomposition algorithm of the dual program. The two last sections are devoted to applications of the cutting hyperplane algorithm to a linear optimal control problem and stochastic programming problems. Author (TAB)

N67-37119 Joint Publications Research Service, Washington, D. C.
THE PROBLEM OF MEETING MOVEMENTS
N. N. Krasovskiy and V. Ye. Tret'yakov 5 Sep. 1967 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 173, no. 2, 1967 p 285–287
(JPRS-42440; TT-67-33069) CFSTI: $3.00

Differential equations are derived to analyze the problem of the minimax of time-to-encounter of tracking and tracked control movements. Consideration is also given to the rule of extreme tracking with the initial problem compared to a problem of limiting speed of action. The main analysis centers on an encounter with respect to only a portion of the coordinates. M.G.J.

N67-37209# Air Force Cambridge Research Labs., Bedford, Mass. Data Sciences Lab.
A SHORT-CUT METHOD OF COMPUTING THE BRUNE AND BOTT–DUFFIN CIRCUIT REALIZATIONS OF POSITIVE REAL BI-ORDER IMMITTANCE FUNCTIONS
Kurt H. Haase Apr. 1967 67 p refs *Its* Phy. Sci. Res. Papers, No. 320
(AFCRL-67-0136; AD-655778)

The paper presents a novel technique for computing the elements of the Brune realization and of the Bott-Duffin realization of a bi-order-n and positive real immittance function F(s) = N(s)/D(s). Polynomials N(s) and D(s) are normalized (N sub n = D sub n = 1) polynomials of the even order n. The computational procedure gives explicit and straight forward instructions and formulas for obtaining the respective circuit elements. The procedure has the advantage of keeping the unavoidable computational inaccuracies to a minimum and of operating exclusively in the real domain of the respective variable. The methods of Horner, Bairstow, and Sturm and some polynomial divisions are the only tools of

numerical analysis that have to be used in the computation, which can easily be performed on a desk calculating machine even if the order n of F(s) is quite high. Author (TAB)

N67-37245* Villanova Univ., Pa. Electrical Engineering Dept.
COMPUTER-AIDED CIRCUIT ANALYSIS Annual Report, 15 May 1966–15 Aug. 1967
Tsute Hang, J. J. Hicks, C. P. Clark, Jr., and R. E. Koogler, Jr. 15 Aug. 1967 247 p refs
(Grant NGR-39-023-004)
(NASA-CR-66463) CSCL 09C

Three articles and a 71-title bibliography on digital computer-aided circuit analysis and design are presented. The first article describes two numerical methods for finding the transient response of linear time invariant networks using mathematical models, the Runge–Kutta method, and the state space approach. In the second article, a program for reliability prediction and tolerance analysis and adjustment is presented (STANPAK—Statistical Tolerance Analysis Package). Given a set of functions and parameters, the program may be used to compute the nominal output values and the mean, the variance, and the tolerance limit for the dependent variable. The program can determine the principal sources of variation, relax or tighten component tolerances to meet reliability levels, and perform a Monte Carlo analysis. The third article concerns digital computer formulations of transfer functions, including: (1) tree and transmittance formulations; (2) conversion and reduction programs; and (3) pertinent block diagrams, flow charts, subroutines, and programming samples. K.W.

N67-37268# Naval Ship Engineering Center, Philadelphia, Pa.
DEVELOPMENT OF A SELF-ADAPTIVE MODEL REFERENCE AUTOMATIC CONTROL SYSTEM Final Report
Pierce H. Zavod 26 Jun. 1967 43 p
(AD-655658)

Automatically controlled systems frequently employ proportional plus integral devices as the controller in the closed loop. The determination of the optimum values of the coefficients of the proportional and integral terms is normally accomplished by trial and error procedures. In an effort to obviate this procedure, a method was developed to compute the optimum values of gain and integration constant of a conventional proportional plus integral controller using an analog computer operating iteratively and in fast time. The results of this computation were applied directly to the settings of a controller in a closed loop system operating in real time. The speed of the optimization process was such that the optimum controller settings were determined for a disturbance after the disturbance had taken place but before the process had responded to any significant degree. Author (TAB)

N67-37284 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
ADJUSTMENT OPTIMIZATION OF A SERVO-LOOP APPLICATION TO SATELLITE CONTROL [OPTIMISATION DU REGLAGE D'UNE BOUCLE D'ASSERVISSEMENT APPLICATION AU CONTROLE D'ATTITUDE D'UN SATELLITE]
Marcel Bismut and Jacques Soubirou 1967 23 p refs In FRENCH; ENGLISH summary Presented at the 5th Congr. of the Intern. Assoc. for Analogical Calculus (AICA), Lausanne, 28 Aug.–2 Sep. 1967
(TP-509(1967))

The determination of the optimum control of a linear system takes frequently the form of a parametric optimization problem whose unknowns are the constants of the matrix of the loop. Two analog methods have been used for finding these constants in a case when the theoretical solution was known. Both have given results: the gradient method appeared as very fast but cumbersome; the selective method has shown to be of a hybrid character. Any of these two methods are applicable to the control of a satellite by means of a wheel; in effect the analysis of this problem leads to expliciting a performance index in a quadratic form. Author

N67-37288*# Pennsylvania State Univ., University Park.
STABILITY TECHNIQUES FOR CONTINUOUS LINEAR SYSTEMS
Allan M. Krall Aug. 1965 208 p refs
(Grant NGR-39-009-041)
(NASA-CR-88498) CFSTI: HC $3.00/MF $0.65 CSCL 09C

The theory of functions of a complex variable is discussed as background for a study of stability techniques for continuous linear systems. The Laplace transform is used for convenience. Bode diagrams and linear differential equations are presented. Discussed are stability techniques for linear, feedback, time-lag, and time-lag feedback systems. Also included is a general stability criterion for feedback systems and computer program calculations for the ordinary and time-lag root-locus methods. S.P.

N67-37300# Polytechnic Inst. of Brooklyn, N. Y.
SYNTHESIS OF FINITE PASSIVE N-PORTS WITH PRESCRIBED POSITIVE REAL MATRICES OF SEVERAL VARIABLES
Tosiro Koga Griffiss AFB, N. Y., RADC, Jul. 1967 51 p refs
(Contract AF 39(602)-3951)
(RADC-TR-67-365; AD-656772)

Positive real functions and matrices of several variables are introduced concerning the design problem of a passive network composed of lumped elements with variable parameters. The importance of these functions and matrices has recently received considerable attention for application to the problem of synthesizing passive networks composed of noncommensurable transmission lines and lumped elements. The problem of synthesizing positive real functions and matrice of several variables has been discussed by several authors. However, the problem has not been solved generally, except for the two-variable lossless case and the case where a two-variable positive real function is prescribed as a bilinear function with respect to one of the two variables. In this paper, a most general solution to the above-mentioned problem is presented. It is shown that an arbitrarily prescribed n x n positive real matrix, symmetric or nonsymmetric, of several variables is realizable as the impedance or admittance matrix of a finite passive n-port. It is further shown that, if the matrix is symmetric, then it is realizable as a bilateral passive n-port. Related problems and discussions are also given. Author (TAB)

N67-37327# Army Electronics Labs., Fort Monmouth, N. J.
APPLICATION OF NET-1 NETWORK ANALYSIS COMPUTER PROGRAM TO THE DC AND TRANSIENT ANALYSIS OF SWITCHING CIRCUITS
William V. Bell and L. W. Leyking May 1967 62 p refs
(ECOM-2834; AD-656458)

The use of the NET-1 Circuit Analysis Program is described, and a comparison is made of the results obtained using a circuit modeled within the computer program and a similar breadboard circuit model. Author (TAB)

N67-37364 Joint Publications Research Service, Washington, D. C.

SYNTHESIS OF AUTOMATIC FREQUENCY CONTROL SYSTEMS RESPONDING TO THE DOPPLER FREQUENCY SHIFT

V. N. Kuleshov 12 Sep. 1967 18 p refs Transl. into ENGLISH from Radiotekhn. (Moscow), v. 12, no. 5, May 1967 p 35–43
(JPRS-42560; TT-67-33188) CFSTI: $3.00

The structural diagram is defined of a linear model of an automatic frequency controller (CHAP) providing minimum mean square noise error in tracking frequency with fixed dynamic error and transient process time. Synthesis methods are used. Examples are analyzed in which possible CHAP structural systems are found which are near optimal in certain areas of values of signal parameters and reception conditions. Author

N67-37384*# Massachusetts Inst. of Tech., Cambridge. Man-Vehicle Control Lab.

THE USE OF THE CHATTER MODE IN SELF-ADAPTIVE SYSTEMS

Syozo Yasui (M.S. Thesis) Sep. 1967 123 p refs
(Grant NsG-577)
(NASA-CR-88700) CSCL 09C

In an on–off relay control system under the chatter mode, the average motion of the plant is completely determined by the equation of the switching function. This fact has been applied in self-adaptive control systems in which the switching function describes the model dynamics, and the chatter mode is reached. The proposed policy of forward gain (switching level) adjustment takes into account the reduction of chatter frequency and of the control force magnitude, in addition to the sustenance of the chatter mode. A simple two dimensional display is used for manual operation and/or monitoring. Several examples are presented to demonstrate the analog computer simulation. The results show satisfactory performance of the gain adjustment mechanism. Known self-adaptive control systems are outlined with emphasis on those using a relay as a key element, and extended application to a class of distributed parameter control systems is considered. Author

N67-37430# White Sands Missile Range, N. Mex. Analysis and Computation Directorate.

APPLICATION OF THE KALMAN FILTER TO SEQUENTIAL OPTIMAL PARAMETER ESTIMATION VIA HOUSEHOLDER'S MATRIX INVERSION METHOD

James Pappas Jun. 1967 101 p refs
(RO-S-67-1; AD-654027) CFSTI: HC $3.00/MF $0.65

A detailed derivation of the computable discrete equations for parameter estimation are developed in a geometrical vector-space setting for the state-space novice. Classical least squares curve fitting when approached with Kalman's sequential prediction-correction techniques look like state-vector feedback control problems. It is hoped that this paper will help bridge the gap between some of the modern and classical theory of systems analysis. Author (TAB)

N67-37447# Texas Univ., Austin. Labs. for Electronics and Related Science Research.

TEXAS BIANNUAL OF ELECTRONICS RESEARCH NUMBER 5. Summary Report, 1 Oct. 1966–31 Mar. 1967

Arwin A. Dougal 15 May 1967 238 p refs
(Grant AF-AFOSR-766-67)
(AFOSR-67-1115; AD-656349)

Recent findings, research investigations in progress, and future plans in the areas of biomedical electronics; information systems, physical, quantum, and plasma electronics; and space, atmospheric, and earth radio sciences are presented. This fifth biannual is highlighted by definitive new results recently obtained in several of these areas. A new numerical classification procedure was applied to a group of psychiatric patients. The procedure yielded a seventy percent agreement with independent clinical diagnosis and indicates that relatively distinct groups exist for the stated diagnostic categories. Experimentation in progress related to the development of mechanized systems for the recognition of spoken English and the recognition of hand printed letters and numbers is summarized. A new feature extraction criterion is found to be mathematically tractable, easier to apply than the minimum probability of misclassification criterion, and to be relevant in learning and pattern recognition. An investigation of field-effect transistor models for use in the Electronic Circuit Analysis Program has been completed and found to give a reasonable simulation of the actual behavior of a pulse inverter circuit. A simple criterion is derived for upper-bounding the rate of convergence of a least square fit algorithm used for recovering function from noisy measurements taken at randomly selected points. Experiments on a non-ohmic current which occurs in thin films of silicon-nitride at high fields are interpreted to attribute the current to a combination of Poole-Frenkel emission, and tunneling. TAB

N67-37479* Maine Univ., Orono.

TIME-OPTIMAL RESPONSE OF FEEDBACK CONTROL SYSTEMS BY MEANS OF DISCONTINUOUS RATE COMPENSATION

Richard J. Levesque (M.S. Thesis) Washington, NASA, Oct. 1967 111 p refs
(Grant NsG-336)
(NASA-CR-867) CSCL 09C

The time response of a discontinuous rate compensated (DRC) system was studied and compared with the response achieved using a bang–bang configuration of the same system. The system configurations were mathematically analyzed, using conventional control system theory and time–optimal control theory. Analog computer models were constructed of the basic system, the basic system with tachometric feedback, the bang–bang system, and the DRC system. The models were programmed on an analog computer, and output response data were obtained from the simulations. It was found that the analog computer simulation method was best for studying time-optimization of feedback control systems. Based on the data, it was concluded that the DRC configuration, switched so that its response overshoot was always a specified small amount, exhibited better overall time response than other configurations in terms of rise time and percent overshoot. M.G.J.

N67-37505# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

TECHNICAL CYBERNETICS

L. P. Krayzmer 24 Apr. 1967 100 p refs Transl. into ENGLISH of the book "Tekhnicheskaya Kibernetika" Moscow, Izd. Energiya, 1964 p 1–88
(FTD-MT-65-422; TT-67-62360; AD-655365)

The basic ideas of cybernetics are popularly expounded as the science of the general principles of control. Primary attention is allotted to technical cybernetics, questions of the control of technical processes, and the creation of artificial controlling systems consisting of devices for perception, transmission, storage, and processing of information. Elementary information from information theory is given as well as that on automatic adjustment and electronic computers. The possibilities of fulfillment by the latter of different logical functions are considered. A considerable quantity of practical applications of cybernetic technology is described both in the field of automation of control, calculation and planning, as

well as in the field of simulation of physiological processes in living organisms. Broader materials are represented regarding information-logical machines, information converters, self-organized systems, and bionic methods of improving cybernetic technology. TAB

N67-37649* North American Aviation, Inc., Downey, Calif. Space Div.

A STUDY OF ELECTRONIC PACKAGES ENVIRONMENTAL CONTROL SYSTEMS AND VEHICLE THERMAL SYSTEMS INTEGRATION. APPENDIX: THERMAL ANALYSIS DATA, PART II Final Report

D. J. Watanabe 21 Jul. 1967 420 p

(Contract NAS8-20320)

(NASA-CR-88706; SID-67-373-3) CSCL 22B

As part of a study of electronic packages, environmental control systems, and spacecraft thermal systems integration, the results of a thermal analysis on the Instrument Unit total heat load and temperature response as well as cold plate heat load are presented in graphical form. R.N.A.

N67-37663* Purdue Univ., Lafayette, Ind. School of Electrical Engineering.

MINIMUM SENSITIVITY OPTIMAL CONTROL FOR NONLINEAR SYSTEMS

V. B. Haas and A. M. Steinberg Aug. 1967 66 p refs

(Grant NGR-15-005-021)

(NASA-CR-88863; TR-EE67-10) CSCL 09C

Relaxed Variational Techniques applied to a minium sensitivity control problem are discussed. Sensitivity of a trajectory is minimized to perturbations in initial conditions. Rather than using the optimal control that does indeed exist and that satisfies the final conditions exactly, a sub-optimal control is used that transfers the system from the given initial state to an arbitrarily small neighborhood of the given final state, which results in better performance than the optimal solution. The sub-optimal control is constructed using the optimal controls of the relaxed problem. It is demonstrated that a sub-optimal chattering control obtained for a minimum time problem can be made a function of the states of the system. Thus lower sensitivity to perturbations in initial states is achieved as well as minimum time. A relation is shown to exist between relaxed problems and singular control. A problem that does not possess an optimal solution, but satisfies some general assumptions, has a singular relaxed solution. Author

N67-37709*# Honeywell, Inc., St. Paul, Minn. Systems and Research Div.

DESIGN OF A LOAD RELIEF CONTROL SYSTEM Progress Report

G. B. Skelton and C. R. Stone 12 Nov. 1965 38 p refs

(Contract NAS8-20155)

(NASA-CR-88513; Rept.-12013-QR-2) CSCL 09C

A review of the current project status, discussion of the computational results obtained to date, and discussion of the generation of wind-induced missile bending-moments are presented. The analysis requirements of the study are almost completed, and the direct-iteration routine is considered powerful and sufficient for determining optimum control gains. It is suggested that future work be based on a more realistic bending-moment-rate expression. Author

N67-37796# California Univ., Livermore. Lawrence Radiation Lab.

NOTES ON POTENTIOSTAT STABILIZATION

J. E. Harrar 18 May 1967 17 p refs

(Contract W-7405-ENG-48)

(UCID-15151) CFSTI: HC $3.00/MF $0.65

A detailed description of the techniques used to stabilize the UCRL coulometer potentiostat, LE-1568, for operation with electrolysis cells is presented. The methodology is applicable to other types of potentiostats and is based on treating the potentiostat-cell system as a typical linear control system. In addition to the technique of steady-state frequency response analysis, a method of transient response testing is outlined. NSA

N67-37842# Sperry Rand Corp., Philadelphia, Pa. UNIVAC Div.

INVESTIGATION OF LOGIC CIRCUIT COMPLEXES: UNIVERSAL FUNCTION MODULES Final Scientific Report, 16 Mar. 1966–15 Mar. 1967

James T. Ellison, Bernard Kolman, and Anthony P. Schiavo 15 Apr. 1967 82 p refs

(Contract AF 19(628)-6012)

(AFCRL-67-0243; AD-655395)

The paper formulates and deals with some problems in universal function modules. A universal function module (UFM) is a variable logic structure capable of performing any function of n variables. The function performed by a UFM may be determined either by external switching or by a permutation of inputs, yielding fixed-connection and variable-connection UFMs, respectively. Among certain subclasses of these structures, optimal realizations are developed with respect to cost and reliability. Two new structures are discussed, one having active redundancy and correcting any single fault and the other possessing passive redundancy and correcting any two faults. Finally, the effect that passage of time has on redundant systems is considered, with special attention to triplication. It is shown that triplication and related reliability-increasing techniques actually decrease the expected time-to-failure of a system. Author (TAB)

N67-37855# Stanford Research Inst., Menlo Park, Calif.

TRANSIENT FREE-SURFACE FLOW Final Report, Sep. 1965–Apr. 1967

Clarence M. Ablow and Vladimir M. Lieskovsky Apr. 1967 50 p refs

(Contract Nonr-5061(00))

(AD-656489)

The theoretical analysis of two-dimensional, transient, free surface, irrotational flows of a perfect, incompressible fluid has been reduced to a routine determination of terms in series. The method has been applied to find the switching speed of a simple model of a hydraulic switch based on the Coanda effect. Experiments with the model showed that the low Reynolds number needed for stability makes perfect fluid theory inapplicable. Author (TAB)

N67-37914# Technische Hochschule Carolo Wilhelmina, Brunswick (West Germany).

CONSTRUCTION AND TESTING OF FULLY ENCLOSED 40-kV SPARK GAPS AND CROWBAR-DEVICES FOR LOW INDUCTIVE CONDENSER BANKS [BAU UND ERPROBUNG VON GEKAPSELTEN 40 kV-FUNKENSTRECKEN UND KURZSCHLIESSERANORDNUNGEN FUER NIEDERINDUKTIVE KONDENSATOR-BATTERIEN]

R. Brilka Apr. 1967 19 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-36)

A study dealing with the construction and the testing of pressurized 40 kV-spark gaps for condenser banks in plasma physics experiments is described. A crowbar device, available for 20 kV only up to the present, has been developed. It has a very low inductivity of about 42 nH. In addition the influence of the casing of the spark gaps on the operative characteristics and the reliability of operation have been determined by several tests. Author (NSA)

N67-38047 Hewlett-Packard Co., Loveland, Colo.
LOW FREQUENCY PHASE SHIFT MEASUREMENT TECHNIQUES
1967 12 p refs *Its* Application Note 81

Techniques for making phase shift measurements at low frequencies ranging from 60 kHz to less than 0.01 Hz are described. The discussion covers how the phase delay encountered by a signal in passing through a servo system under test is measured by oscilloscope comparison with the variable phase output of the HP Model 203A variable phase function generator. A method of overcoming flicker in the scope display at very low frequencies is described. The theory of operation of the variable phase function generator, how to calibrate the generator's variable phase control, and how to use the generator with an HP Model 3300A/3302A function generator to derive multiple phase outputs are also described. Author

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N67-36682# California Univ., Los Angeles. Dept. of Physics.
VARIABLE ENERGY EXTRACTION FROM A NEGATIVE ION CYCLOTRON AND RELATED MEASUREMENTS
Arthur C. Paul Jun. 1967 204 p refs
(Contract Nonr-233(44))
(P-79; AD-655840)

A scheme was developed for the variable energy extraction of 25 to 48 MeV protons into a common external beam transport system. The extraction is accomplished by stripping negative hydrogen ions with a thin foil. The magnetic field is held constant while the radius and azimuth of the stripping foil are chosen so that the trajectories for any energy cross at a common point outside the cyclotron vacuum tank. A small combination magnet placed at this crossover point bends the trajectories into a common beam transport system. The first order ion optic matrix representing the fringing field of the cyclotron was calculated at five different energies. An ion optic calculation of the beam transport system is given for two different phase space vectors at the stripper. Comparison is made with the observed operating values. Author (TAB)

N67-36820# Aerospace Corp., El Segundo, Calif. Aerodynamics and Propulsion Research Lab.
GROUND TEST FACILITIES FOR AEROTHERMODYNAMIC SIMULATION OF BALLISTIC REENTRY VEHICLE NOSE-TIP CONDITIONS
William E. Welsh, Jr. May 1967 40 p refs
(Contract AF 04(695)-1001)
(TR-1001(2240-10)-6; SSD-TR-67-105; AD-655784)

A study was made of ground test simulation of flight conditions of high performance ballistic reentry vehicles, as performed for assessment of ablation performance of nose-tip materials. The study utilized a generalized representation of vehicle materials, configurations, and trajectories. Existing high-temperature steady-flow test facilities were found to be adequate for simulation of peak heating, shear, and pressures corresponding to those for a vehicle reentering the atmosphere at 25,000 ft/sec, at an angle of 30 deg, with a ballistic coefficient of about 800. Improved test facility conditions are required for reentry vehicles of ballistic coefficients higher than 800. The corresponding power, pressure, and enthalpy requirements are shown for arbitrary values of ballistic parameters. Possible advanced facilities for the achievement of higher pressure, enthalpy, and heating rate are compared and briefly discussed. Among these are: a higher-powered heated-flow test facility, a ballistic range test facility, a thermal-radiation augmentation method, and improvements in existing heated-flow facilities. Author (TAB)

N67-36961# Institut za Nuklearne Nauke (Boris Kidric), Belgrade (Yugoslavia).
A PRACTICAL LABORATORY COLD BOX FOR USE IN BIOCHEMICAL INVESTIGATIONS FROM +4° TO −15°C
Miroslav Milosevic *In its* Bull. of the Boris Kidric Inst. of Nucl. Sci., Vol. 17, No. 2 1966 p 152–154 refs (See N67-36954 22-34)

Technical specifications are given on a laboratory cold box designed so that experiments can be carried out at reduced temperatures while the experimenter works at room temperature. A Freon 12 mixture is used for refrigeration; the maximum refrigeration which can be reached and maintained is −15°C. The double door and window are made of plexiglass, and a car windshield wiper is installed to remove the moisture from the window. Allowance for work with radioactive isotope tracers is provided in the design. M.G.J.

N67-37003# Monsanto Chemical Co., Springfield, Mass.
AN IMPROVED OVEN FOR ACCELERATED AGING OF POLYVINYL CHLORIDE COMPOUNDS
Roger M. Sherwood and Stanely J. Boronski [1967] 6 p
(AD-656202)

It was demonstrated that reproducibility of accelerated aging results can be attained by using diffusion screens at the inlet panel in conjunction with a rotating specimen rack. It is believed that, since removal of the existing inlet panel is unnecessary, all makes of forced-convection ovens using wall-to-wall air flow can easily be converted to diffusion ovens. The cost of this conversion is minimal because the diffusion principle is simple. Best of all, the oven capacity remains essentially unchanged, and the oven still can be loaded and unloaded quickly and easily. Author (TAB)

N67-37038* Texas A&M Univ., College Station. Low Speed Wind Tunnel Section.
GUST SIMULATION IN A WIND TUNNEL Final Report
Richard E. Thomas and Bruce T. Morland, Jr. Jul. 1967 60 p refs
(Grant NGR-44-001-036)
(NASA-CR-66462; TR-67-52) CSCL 14B

The results of initial studies of the use of air injection to simulate atmospheric processes such as gusts and wind shears in a wind tunnel are reported. Longitudinal gusts were produced at frequencies above 50 c.p.s. with amplitudes of 5.5 f.p.s. in an

83 f.p.s. stream, while at lower frequencies gusts with amplitudes up to 21 f.p.s. were produced. The frequency response characteristics of the injector-tunnel system were measured and found to be a function of tunnel configuration, injector configuration and air speed. Upstream injection was much more efficient than was downstream injection. Two dimensional gusts also were studied. At frequencies above 50 c.p.s. longitudinal gusts at 3.5 f.p.s. were produced in association with transverse gusts of 2 f.p.s. At lower frequencies longitudinal gusts of 6 f.p.s. were produced with transverse gusts of 8 f.p.s. Side wall air injection also was used and produced longitudinal gusts at frequencies above 50 c.p.s. with amplitudes of up to 0.8 f.p.s. in an 80 f.p.s. stream, while at lower frequencies gusts with amplitudes up to 2.2 f.p.s. were produced. The feasibility of using air injection nozzles to produce wind shears was also investigated, and wind shears with gradients from 130 f.p.s. to 165 f.p.s. per foot were produced. Author

N67-37065 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

LOW DENSITY VISUALIZATIONS [VISUALISATION A FAIBLE MASSE VOLUMIQUE]

Claude Veret 1967 18 p refs In FRENCH; ENGLISH summary Presented at the 30th Reunion of the Propulsion and Energetics Group of AGARD on New Exptl. Tech., Munich, Exptl. 11–15 Sep. 1967

(TP-483(1967))

The Schlieren method is used for visualizations in supersonic flow but its sensitivity is very much reduced in hypersonic flows because of the low density. In this case there are advantages in using the phase contrast method. Both methods are described and their sensitivity are compared. Examples of wind-tunnel hypersonic flow visualizations are given. The conditions of application of these methods to visualize flows which are themselves luminous (plasmas and flames) are indicated. Author

N67-37194# California Univ., San Diego. Scripps Inst. of Oceanography.

TRANSDUCER CALIBRATION FACILITY AT SAN VICENTE LAKE

Daniel K. Gibson and Richard P. Lewis 20 Jan. 1967 57 p

(Contract Nonr-2216(05))

(MPL-U-14/67; AD-656467)

A 24 X 50 general purpose research platform has been located at San Vicente Lake. The facility is moored in 100 ft-minimum depth of water with approximately 4500 ft of unobstructed range. The barge is supplied with 440-3 phase ac power as well as 110-220 unregulated and 110 regulated 1 phase ac power. Boat and loading facilities are available. Equipment handling gear and tool set are included on the barge. Test capabilities at the facility include: source and receiver response, directivity pattern plots, null-balance measurements, Z and theta measurements. A set of calibrated PZT4 cylindrical crystals are available to accomplish the above tests. System frequency response is from 1kHz to 100 kHz. A set of checkout procedures and rules governing facility use are included in this report. A complete facility electronic equipment description and a set of suggested operational test procedures are also included. Author (TAB)

N67-37224# California Univ., Livermore. Lawrence Radiation Lab.

FISSION CHAMBERS

Arthur Toor 30 Jan. 1967 9 p

(Contract W-7405-ENG-48)

(UCID-15055) CFSTI: HC $3.00/MF $0.65

The feasibility of building fission chambers with the dual role of measuring the differential energy spectrum of neutrons from a device and making neutron fission cross-section measurements with a device used as a neutron source (both utilizing time-of-flight techniques) was investigated. The fissionable materials used in the detectors were ^{233}U, ^{235}U, ^{238}U, and ^{239}Pu. A comparison of plating techniques was made with thickness uniformity and operating reliability used as the determining criteria. Voltage counting rate characteristics were examined for several fill gases with fill pressures ranging from 1 to 5 atmospheres absolute. Some of the results of this study are summarized. NSA

N67-37319 France. Office National d'Etudes et de Recherches Aerospatailes, Chatillon-sous-Bagneux.

HELICOPTER ROTOR TESTING SYSTEM IN THE S1 WIND-TUNNEL OF THE O.N.E.R.A. MODANE CENTER [INSTALLATION D'ESSAIS DE ROTORS D'HELICOPTERES DANS LA GRANDE SOUFFLERIE DE MODANE-AVRIEUX]

Andre Schweisch 1967 12 p refs In FRENCH; ENGLISH summary Presented at the Reunion of AGARD on the Aerodynamiques of Vertical Takeoff Planes, Goettingen, 11–13 Sep. 1967

(TP-494(1967))

In this paper a testing system for helicopter rotors and S/VTOL propellers is described. It is used in one of the 8 m. removable test-sections of the sonic wind-tunnel S1 at the ONERA testing Center of Modane. This system, being developed, allows testing large diameter rotors whose axes can be rotated in the vertical plane such that $*-95^{\circ}<\alpha_2<+25^{\circ}$. The test-section is 8 m in diameter and 14 m in length. The maximum useful power is 736 kW and the rotor rotation rate can be continuously varied from 800 r.p.m. to 2400 r.p.m. A braking device allows autorotation testing. A six-component balance supports the hub of the rotor and measures the resulting aerodynamic torque. A collector including 50 rings provides the electric outputs from the rotating parts of the rotor (loads on the pitch-control rods, local pressure on the blades, main stresses). The blade wake can be explored and a stroboscopic device allows detecting the deformation of the blades. Author

N67-37415# Bureau of Mines, Amarillo, Tex. Helium Research Center.

DESCRIPTION OF A HIGH PRESSURE HIGH ACCURACY BURNETT COMPRESSIBILITY APPARATUS

John E. Miller Oct. 1967 15 p refs

(BM-IC-8350)

A high accuracy Burnett apparatus for use at 12,000 psi and 0° to 65°C has been constructed. The apparatus is patterned after Burnett's original apparatus, but the working pressure is much higher and elastic distortion can be essentially eliminated. An operating procedure to permit faster experimental measurements is suggested. Author

N67-37454# Battelle Memorial Inst., Columbus, Ohio.

THE SUBSONIC WIND TUNNEL OF BATTELLE COLUMBUS LABORATORIES

Vernon O. Hoehne 15 Jun. 1967 54 p refs

(AD-656486)

The Subsonic Wind Tunnel of Battelle Columbus Laboratories has been developed to provide a quality research tool that is economical to operate. It can provide air velocities to 250 fps with a turbulence level of 0.10 percent or less through a 55-inch-high by 38.5-inch-wide test section. Models are mounted directly to the walls, floor, or ceiling of the test section, or on a sting. The report is a description of the tunnel, its management procedures, and cost to users. Author (TAB)

N67-37480# David Taylor Model Basin, Washington, D. C.
PERFORMANCE AND CORRELATION STUDIES OF THE BUSHIPS PARENT HYDROFOIL AT SPEEDS FROM 40 TO 75 KNOTS Final Report
Peter K. Spangler Dec. 1966 68 p refs
(DTMB-2353; AD-655433)

The hydrofoil was tested through a 1.44 to 12.44 deg range of angle of attack and depths of immersion of 0.5, 1.0, and 1.5 chords. Lift and drag measurements were made and cavitating flow conditions were determined from high speed photographs. The order of transition of cavitation with increasing speed was: base cavitation, partial upper surface cavitation, ventilation, and supercavitation. Abrupt transitions and overlapping of cavitation regions occurred. Lift coefficients were constant with base cavitation and complete ventilation. At low angles of attack, lift increased with decreasing draft. The hydrofoil vibrated during 65 percent of the tests. In the lowest frequency mode a relationship existed between speed and cycle length, independent of angle of attack, depth, and cavitation. Author (TAB)

N67-37475# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
SYSTEM DESIGN FOR THE ATMOSPHERIC SCIENCES OFFICE WIND RESEARCH FACILITY
J. D. Horn and J. A. Hunt May 1967 51 p refs
(ECOM-5127; AD-656464)

System design outlines are presented for measurement of aerodynamic parameters in a wind tunnel. Pressure measurements are obtained by an electromanometer system with readout for twelve sensing stations. Velocity is determined by Pitot tube and hot wire devices. Models may be mounted in three modes on a sting and sector system for experimental runs. Vibration sensors and dynamic response simulation are available. Temperature gradients are determined by a nine-element thermocouple array. Provisions are made for a digital data acquisition system and visual analog display. Author (TAB)

N67-37550# Stanford Univ., Calif. Stanford Linear Accelerator Center.
TWO-MILE ACCELERATOR PROJECT Quarterly Status Report, 1 Oct.–31 Dec. 1966
May 1967 81 p refs
(Contracts AT(04-3)-400; AT(04-3)-515)
(SLAC-73) CFSTI: HC $3.00/MF $0.65

Various aspects of the SLAC development during the period October 1, 1966, to December 31, 1966, are discussed. These include accelerator operation, system and component operation, accelerator physics, klystron studies, mechanical engineering and fabrication, instrumentation and control, electronic engineering, counting electronics, research area developments, and physics research equipment development. NSA

N67-37647*# General Electric Co., Schenectady, N. Y. Research and Development Center.
QUANTITATIVE LEAK TEST DESIGN GUIDE
J. L. Manganaro and D. L. Hollinger Aug. 1967 114 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951763)
(NASA-CR-88504; S-67-1135) CFSTI: HC $3.00/MF $0.65
CSCL 14B

Rapid and accurate procedures for determining leak rates using a calibrated enclosure technique were developed. The test object is pressurized with helium and the helium leak rate determined, from which the leak rates of other gases can be estimated. Three different methods of using this technique are described and the results of experimental test run by these methods are reported. All three methods involve pressurizing the test object with pure helium, enclosing the object in a bag or tent, sensing the helium content in the enclosure and determining the rate of current increase in a mass spectrometer tube, and calibrating the current increase in the mass spectrometer in terms of a helium rate by either comparing to known helium leaks, or injecting a known quantity of helium. The major equipments required for this procedure are described along with their design criteria. The accuracy and speed of the calibrated enclosure technique vary with enclosure volume, test leak rate, and leak detector sensitivity and stability. R.N.A.

N67-37700# Brookhaven National Lab., Upton, N. Y.
SUPERCONDUCTING MAGNETS FOR BEAM HANDLING AND ACCELERATORS
W. B. Sampson [1966] 12 p refs Presented at the 2d Intern. Conf. on Magnet Technol., Oxford
(BNL-11394; CONF-670705-3) CFSTI: HC $3.00/MF $0.65

The design of superconducting beam handling magnets is discussed for two general types: dipole for momentum selection and quadrupoles for beam focusing. Accelerator superconducting magnets are then investigated for fixed field machines and synchrotrons. NSA

N67-37841# Los Alamos Scientific Lab., N. Mex.
PHERMEX: A PULSED HIGH-ENERGY RADIOGRAPHIC MACHINE EMITTING X-RAYS
Douglas Venable, ed., D. O. Dickman, J. N. Hardwick, E. D. Bush, Jr., R. W. Taylor et al 15 May 1967 252 p refs
(Contract W-7405-ENG-36)
(LA-3241) CFSTI: HC $3.00/MF $0.65

The design aspects and the capability of PHERMEX as an electron accelerator and a source of penetrating gamma rays for flash radiography are discussed. NSA

N67-37985*# Aerojet-General Corp., Sacramento, Calif.
ACTIVATION AND INITIAL TEST OPERATIONS, LARGE ROCKET ENGINE—TURBOPUMP TEST FACILITIES Technology Report
D. H. Clark 1 Aug. 1967 27 p refs
(Contract NAS3-2555)
(NASA-CR-54824; AGC-8400-2) CSCL 14B

Testing of the turbopump assembly for the M-1 Engine presented a major challenge because of the complexity of the tests, the size of the hardware, and the amount of propellants required. This report describes the facilities that were built, the activation procedures that were followed, and the facility checkout tests that were made to meet this challenge. Author

N67-37987*# Aerojet-General Corp., Sacramento, Calif. Liquid Rocket Operations.
ACTIVATION AND INITIAL TEST OPERATIONS, LARGE ROCKET ENGINE—THRUST CHAMBER TEST FACILITIES Technology Report

D. H. Clark 8 Aug. 1967 35 p refs
(Contract NAS3-2555)
(NASA-CR-73200; AGC-9400-3) CFSTI: HC $3.00/MF $0.65
CSCL 14B

Testing of the thrust chamber assembly for the NASA M-1 Engine at a vacuum equivalent thrust level of 1.5 million lbf imposed several new facility requirements and created unique testing problems. This report describes the unusual aspects of facility activation, the problems encountered, the corrective actions taken, and the initial operation of the test facilities. Author

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N67-36684# California Univ., Berkeley. Aeronautical Sciences Div.
A NUMERICAL SOLUTION OF THE BOLTZMANN EQUATION FOR A TWO-DIMENSIONAL GAS
Frank Robben Apr. 1967 42 p refs
(Contract Nonr-222(45); Grant AF-AFOSR-538-67)
(AS-67-4; AD-655647)

An attempt to solve the Boltzmann equation numerically was carried out by means of a more direct method than the Monte-Carlo technique. The initial value problem of the energy relaxation of a two-dimensional gas of hard spheres was studied, using direct numerical integration techniques. A finite difference approximation to the Boltzmann equation was used. While the results are qualitatively correct, conservation of energy and number were violated to the extent of about 4% per collision. On comparing the detailed results to that predicted by a Krook model, quantitative differences are noted. It is believed that the inaccuracies of the solutions obtained are due to a singularity in the collision integrals. Author (TAB)

N67-36698*# Farnham (Frank C.) Co., Philadelphia, Pa.
EXPERIMENTAL INVESTIGATION OF THE HYPERSONIC FLOW OF A RAREFIED GAS AROUND A SPHERE [EKSPERIMENTAL'NOYE ISSLEDOVANIYE OBTEKANIYA SFERY GIPERZVUKOVYM POTOKOM RAZREZHENNOGO GAZA]
F. S. Voronin Washington, NASA, Sep. 1967 8 p refs Transl. into ENGLISH from Izv. Akad. Nauk. SSSR, Mekhan. Zhidkosti i Gaza (Moscow), no. 2, 1967 p 148–151
(Contract NASw-1497)
(NASA-TT-F-11194) CSCL 20D

An experimental investigation was made of the pressure distribution at the surface of a sphere at free-stream Reynolds numbers ranging from 10^2 to 10^6, with the aim of obtaining experimental data for the determination of the effect of Re on the hypersonic flow around a sphere. In addition, the flow is visualized with the aid of glow-discharge techniques. The results obtained for Reynolds numbers ranging from 2×10^4 to 3×10^6 indicate that the position of the point of flow separation at the sphere depends uniquely on the free-stream Mach number. For $Re<10^3$, the viscosity of the flow is more pronounced, which leads to an increase in the region of attached flow on the sphere. Author

N67-36707# New York Univ., N. Y.
A FORTRAN PROGRAM FOR THE CALCULATION OF COMPRESSIBLE LAMINAR BOUNDARY LAYERS
Patricia Anton Dec. 1966 56 p refs
(Contract Nonr-285(63))
(NYU-AA-66-71; AD-655237)

A FORTRAN computer program for the numerical solution of the compressible laminar boundary layer equations is presented. The method of solution employed is an implicite finite difference integration scheme, by which the velocity components and the temperature are determined in the physical plane. All possible boundary conditions and arbitrary initial conditions can be treated. The pertinent aspects of the solution are discussed in detail. Operating instructions are presented along with a flow chart and the listing of the program and sample calculations are included for check-out purposes. Author (TAB)

N67-36800# General Applied Science Labs., Inc., Westbury, N. Y.
ANALYSIS AND USER'S MANUAL FOR IMPLICIT FINITE-DIFFERENCE COMPUTER PROGRAM FOR LAMINAR COMPRESSIBLE BOUNDARY LAYER CALCULATIONS
Technical Report, Apr. 1965–Nov. 1966
F. Lane, E. Lieberman, and H. Fox 29 Nov. 1966 110 p refs
(Contract AF 33(615)-2568)
(TR-629; AD-655681)

An IBM 7090/94 computer program to calculate flow properties within boundary layers, for an ideal compressible gas, was completed. The governing differential equations are approximated by an implicit finite-differencing scheme which is posed directly in (nondimensionalized) physical coordinates; the streamwise coordinate is scaled with respect to a reference length, while the normal coordinate is so scaled and also stretched by the square root of a reference Reynolds number. The program is designed for bodies that are either two-dimensional or axisymmetric and the gas (air) is considered to be calorically perfect according to the equation of state, p = rho RT. Initial data through the boundary layer must be prescribed, as well as the streamwise variation of pressure, and of either wall temperature, T sub w or the gradient of T sub w normal to the wall, partial T sub w/partial y. A boundary layer of zero thickness at the initial station may also be accommodated. All inputs are specified in physical coordinates. Author (TAB)

N67-36802# Douglas Aircraft Co., Inc., Long Beach, Calif. Aircraft Div.
NUMERICAL SOLUTION OF THE TURBULENT-BOUNDARY-LAYER EQUATIONS
A. M. O. Smith and T. Cebeci 29 May 1967 146 p refs
(Contract NOw-66-0324-c)
(DAC-33735; AD-656430)

The report presents a numerical solution of turbulent boundary-layer equations for both compressible and incompressible flows. An eddy viscosity concept is used to eliminate the Reynolds shear-stress term, and an eddy-conductivity concept is used to eliminate the time mean of the product of fluctuating velocity and temperature. The turbulent boundary layer is regarded as a composite layer consisting of inner and outer regions, and a separate

expression for eddy viscosity is used in each region. The ratio of eddy-viscosity to eddy conductivity is assumed to be constant. An implicit finite-difference method is used in the solution of both momentum and energy equations after they are linearized. Author (TAB)

N67-36826# Massachusetts Inst. of Tech., Cambridge. Gas Turbine Lab.

CONDENSATION OF SUPERSATURATED ORGANIC VAPORS IN A SUPERSONIC NOZZLE

Daniel B. Dawson Apr. 1967 104 p refs

(Contract Nonr-3963(07))

(Rept.-90; AD-655473)

Experiments were performed involving condensation of supersaturated benzene and chloroform vapors in a supersonic nozzle, with compressed air as the carrier gas. Experiments showed that the magnitude of the water vapor content of the carrier air made no observable difference in the condensation behavior of either fluid. It was demonstrated that addition of small amounts of these fluids to the carrier air tended to reduce the thickness of the boundary layer in the nozzle. Comparison of experimental results with theory show, without making any adjustments to physical properties of condensate droplets to account for size, that incidence of condensation for chloroform can be predicted by the revised theory of nucleation, whereas benzene incidence can be predicted by neither revised nor classical theory. These results, combined with prior data on other fluids, show that at present neither theory seems to be generally applicable. In support of previous conclusions, the problem may well be the assumption that bulk properties may be assigned to small (30 - 50 molecules) droplets of condensate. Author (TAB)

N67-36844# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.

THE PRECESSION AND NUTATION OF DEFORMABLE BODIES. III: OSCILLATIONS OF INCOMPRESSIBLE VISCOUS GLOBES

Zdenek Kopal May 1967 20 p ref *Its* Mathematical Note No. 513

(DI-82-0618; AD-655223)

The purpose of the report is to specify the form of the characteristic functions, and the nature of the spectrum of characteristic frequencies, of free nonradial oscillations of selfgravitating incompressible fluid globes of constant density and viscosity, in terms of which their forced oscillations (such as lunar librations invoked by the gravitational attraction of the Earth and the Sun) are later to be expanded. Kelvins problem is generalized to configurations of arbitrary viscosity, and solved analytically in a closed form in terms of complex functions. Author (TAB)

N67-36878* Farnham (Frank C.) Co., Philadelphia, Pa.

SUPERSATURATION AND CONDENSATION SHOCK DURING FLOW OF POTASSIUM VAPOR [PERENASYSHCHENIYE I SKACHOK KONDENSATSII PRI TECHENII PARA KALIYA]

G. L. Podvidz Washington, NASA, Aug. 1967 12 p refs Transl. into ENGLISH from Teplofiz. Vysokikh Temperatur, Akad. Nauk SSSR (Moscow), v. 5, no. 1, 1967 p 121–129

(Contract NASw-1497)

(NASA-TT-F-11182) CSCL 20D

The adiabatic flow of potassium vapor without the formation of a liquid phase is considered. The supersaturated state which forms is characterized by supercooling and supercompression. It undergoes a transition to an equilibrium state by means of a condensation shock, which is considered as a discontinuity surface. Condensation is considered at subsonic and supersonic velocities of the flow in front of the shock. The flow of potassium vapor is computed with supersaturation and a condensation shock in the range $T_0 = 1,500–873.16°$ K and $M_0 = 0–1$. Author

N67-36883 Aeronautical Research Council, Gt. Brit.

NITROGEN CONDENSATION IN THE R.A.R.D.E. HYPERSONIC GAS TUNNEL

J. E. Bowman 1967 14 p refs

(ARC-CP-956)

The effects of condensation of the working gas (nitrogen) on pitot and static pressures in the R.A.R.D.E. hypersonic gun tunnel were examined and the onset of condensation determined for flow Mach numbers of 8.4, 10.4 and 12.9. A large degree of supersaturation was observed at the two higher Mach numbers. Author

N67-36887# Naval Ordnance Lab., White Oak, Md.

CAVITY SHAPES AT VERTICAL WATER ENTRY—A COMPARISON OF CALCULATED AND OBSERVED SHAPES

Harvey I. Abelson 29 Jun. 1967 27 p refs Revised

(NOLTR-67-31; Ballistics Res. Rept.-171; AD-655227)

For vertical water entries which result in the formation of open cavities, the cavity shapes as predicted by Birkoff's hydraulic flow model are shown to correspond very well to observed cavity shapes for spheres of different sizes and materials. Author (TAB)

N67-36914# Toronto Univ. (Ontario). Inst. for Aerospace Studies.

ACOUSTIC ENERGY FLUX FROM SHOCK-TURBULENCE INTERACTION

H. S. Ribner Jul. 1967 26 p refs

(Grant AF-AFOSR-672-66)

(UTIAS-TN-108; AFOSR-67-0221; AD-655795)

The analysis of the sound field generated by the passage of isotropic turbulence through a shock of finite strength (Ribner, 1953, 1954) was extended to provide the flux of acoustic energy. The energy flux varies almost linearly with shock density ratio, reaching a maximum at infinite Mach number of 0.062 of the flux of turbulence kinetic energy. Direct comparison with a result obtained by Lighthill (1953) is misleading. His energy relations, reckoned relative to a frame moving with the fluid, must be converted to the shock-fixed frame used in this report. The converted results of his theory (weak shocks) and the results of the authors theory (arbitrary shocks) appear to show a similar asymptotic behavior for vanishing shock strength; they diverge with increasing shock strength. Author (TAB)

N67-36936# Polytechnic Inst. of Brooklyn, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
CONSERVATION FORM OF THE EQUATIONS OF HYDRODYNAMICS IN CURVILINEAR COORDINATE SYSTEMS
James L. Anderson (Stevens Inst. of Tech.), Stanley Preiser, and Ephraim L. Rubin May 1967 18 p refs
(Contract Nonr-839(34))
(PIBAL-1021; AD-654890)

It is shown how to transform the equations of hydrodynamics so that conservation form is retained in any curvilinear coordinate system. Author (TAB)

N67-36953# General Electric Co., Philadelphia, Pa. Missile and Space Div.
HIGH VELOCITY RADIATING FLOWS Final Report, Apr. 1963–Jun. 1967
R. G. Breene, Jr., V. L. Kirk, J. L. Kulander, R. T. Liner, R. J. Mjolsness et al 1 Jul. 1967 18 p refs
(Contract Nonr-4188(00))
(AD-656766)

Work on radiation problems is divided into three headings: radiative transfer theory, radiation properties, and radiating flows. Radiative transfer theory involves the solution of the radiative transfer equation. The computation of the local physical properties which appear in the radiative transfer equation, the absorption coefficient and the source function, appear in the section called Radiative Properties. The subjects of radiative properties and radiative transfer theory find application in radiating flow fields. The inelastic collision of electrons and molecules, in particular the excitation of rotational energy, is discussed. TAB

N67-36986# Michigan Univ., Ann Arbor. Dept. of Aerospace Engineering.
CONDENSATION IN A RAPIDLY EXPANDING METAL VAPOR-INERT GAS MIXTURE Interim Technical Report
P. M. Sherman, D. D. Mc Bride, and E. Oktay Wright-Patterson AFB, Ohio, ARL, Apr. 1967 92 p refs
(Contract AF 33(615)-2307)
(ARL-67-0071; AD-656708)

An investigation of the condensation of metal vapor in an inert carrier gas accelerated through nozzles was carried out. The mixture used is primarily zinc vapor in helium gas. Two types of condensation measurements are made. Measurement of particle size is made in the tunnel. Determination of condensation onset point is made in the exploding-wire system. Particle size is determined by means of a shuttered sampling device developed for the purpose combined with electron microscope techniques evolved. The condensation onset point is determined by nozzle static pressure measurement. Simplified computational analyses are made to predict conditions for the measured condensation onset point. They are also used as a guide for the more complex two component non-equilibrium expansion computation which may predict the location of the onset point as well as particle size. Measurements of particle size at the exit of a nominal Mach 25 (helium) nozzle showed a major portion of the total particles to be less than approx. 70 A in diameter. The pressure measurements made in a nominal Mach 3 nozzle indicated a large degree of supercooling. Author (TAB)

N67-37057# New York Univ., N. Y. Courant Inst. of Mathematical Sciences.
THE UNIQUENESS OF CERTAIN FLOWS IN A CHANNEL WITH ARBITRARY CROSS SECTION
Arthur S. Peters Jun. 1967 45 p refs
(Contract Nonr-285(55))
(IMM-355; AD-655643)

The report presents a proof of the uniqueness of a parallel three-dimensional shear flow in a channel with arbitrary cross section where the speed of the flow is not less than the highest critical speed. The investigation also includes a two-dimensional analysis in which it is assumed that while the flow velocity varies with the depth, the density also depends on the depth; and for this case the development leads to a formula which gives a good approximation to the highest critical speed. Author (TAB)

N67-37086# Martin Co., Orlando, Fla.
TRANSITION TO TURBULENCE FOR SUBMERGED INCOMPRESSIBLE AND FREE COMPRESSIBLE FLUID JETS
C. P. Mc Kensie and W. P. Dorsey Jun. 1967 60 p refs
(Contract AF 49(638)-1725)
(OR-8882; AFOSR-67-1894; AD-656780)

Experimental data are presented which verify the least Reynolds number at which transient disturbances are amplified and transition to turbulence occurs. The least critical Reynolds number data shows good agreement with stability analysis predictions performed by Curle. The observations reported were obtained from jets formed by supply nozzles with aspect ratios of 1. The range of aspect ratios was limited around unity because the results are then directly applicable to microminature fluid amplifiers. In addition to critical Reynolds number determination, data are presented that gives the distance at which transition to turbulence occurs for several typical geometries. Author (TAB)

N67-37088# Michigan Univ., Ann Arbor. Gas Dynamics Labs.
VISCOUS TRANSONIC SPIRAL AND RADIAL FLOW
M. Sichel and Y. K. Yin Jul. 1967 27 p refs
(Contract DA-31-024-ARO(D)-276)
(Rept.-07146-2-T; AROD-3537.4-E; AD-656749)

Similarity solutions of the viscous transonic equation describing source, and source vortex flows were found. These solutions contain shock like transitions from the supersonic to the subsonic branch of the corresponding inviscid solutions, while the singularity near the sonic point of the inviscid solutions is shifted to a smaller radius. It is shown that this similarity solution is identical to the transonic viscous compressible source and sink flow solutions of Wu (1955) and Sakurai (1958). Author (TAB)

N67-37099# California Inst. of Tech., Pasadena. Hydrodynamics Lab.
FLUID FREE SURFACE PROXIMITY EFFECT ON A SPHERE VERTICALLY ACCELERATED FROM REST
John G. Waugh and Albert T. Ellis Jun. 1967 36 p refs
(Contract N600(19)-59368)
(E-124.2; AD-656429)

Theory is developed to estimate the effect of free surface proximity on the initial added mass of a sphere accelerated vertically upward from rest in an ideal fluid. It is assumed that the acceleration regime is sufficiently brief that inertial forces predominate and gravitational effects may be neglected. Results of tests in water indicate that while there are slight viscous and gravitational effects over the acceleration regime, the agreement between theory and experiment is good. It is concluded that over briefer acceleration regimes these effects would decrease and the agreement would improve. Author (TAB)

N67-37204# Aeronautical Research Council (Gr. Brit.).
TEMPERATURE AND PRESSURE STUDIES IN THE RESERVOIR OF A REFLECTED-SHOCK HYPERSONIC TUNNEL
K. C. Lapworth and J. E. G. Townsend London, HMSO, 1967 46 p refs Supersedes NPL-AERO-1127; ARC-26110
(ARC-R&M-3479; NPL-AERO-1127; ARC-26110) HMSO: 18s 6d

Observations of the development with time of the temperature and pressure measured in the region just upstream of the nozzle of a reflected-shock hypersonic tunnel are presented and compared with ideal shock-tube theory. Differences between ideal theory and these observations are attributed to boundary-layer effects and contact region behavior. Author

N67-37205# Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
INVESTIGATION OF A THEORY FOR THE STRUCTURE OF THE VISCOUS SUBLAYER IN WALL TURBULENCE
Roy Cassel Elswick, Jr. Jun. 1967 92 p refs
(Grant Nonr(G)-00043-65)
(AD-656089)

Based on the assumption of equilibrium of the average rate of change of the total turbulent energy, differential eigenvalue equations for the structure of finite-amplitude disturbances invariant in the streamwise direction are obtained. The minimum viscous sublayer thickness is determined using a simplified form of the equations. The minimum critical thickness non-dimensionalized by shear velocity and kinematic viscosity is found to be 4.69. The numerical results are also compared with the measurements in the sublayer by Bakewell (1966). It is suggested that the so-called energy-containing range of the spectrum may be associated with the large eddy structure. Author (TAB)

N67-37240# Yale Univ., New Haven, Conn. Dept. of Engineering and Applied Science.
MAYER'S THEORY OF CONDENSATION AND HOMOGENEOUS NUCLEATION
Jean-Yves Parlange Jul. 1967 22 p refs
(Contract Nonr-609(47))
(Rept.-9; AD-656640)

A study was made of Mayers limiting processes (infinite series and V approaches infinity) in detail, showing that the density, rho sub c, where condensation takes place and the density rho sub c (infinity) where condensation should take place according to Mayer are indeed equal. TAB

N67-37259*# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
NOZZLE FLOWS WITH COUPLED VIBRATIONAL AND DISSOCIATIONAL NONEQUILIBRIUM
Duvvuri Tirumalesa Aug. 1967 173 p refs
(Grant NsG-633)
(NASA-CR-66474; UTIAS-123) CSCL 20D

A detailed study is presented of one-dimensional inviscid nozzle flows with coupled vibrational and dissociational nonequilibrium. The ordinary coupled differential equations are integrated using the fourth order Runge–Kutta method on an IBM-7090 computer for several reservoir conditions. The method is used to predict the flow properties in the UTIAS hypersonic shock tunnel nozzle system. The flow quantities are strongly dependent on the vibrational and dissociational models used in the analyses. It was assumed that the vibrational state of the gas may be represented by a single vibrational temperature and that the effect of vibrational nonequilibrium on rates of dissociation may be taken into account by the introduction of a parameter which has the dimensions of temperature and which gives a higher probability for dissociation from higher vibrational energy levels. The dependence of this parameter on translational temperature is derived. A qualitative study of the effects of the atom–molecule exchange reaction and relaxation from a higher to lower vibrationally excited state on the vibrational relaxation is carried out by shortening the vibrational relaxation times from those measured behind normal shocks. Author

N67-37269# California Inst. of Tech., Pasadena. Engineering Div.
A METHOD OF CALCULATING QUASI TWO-DIMENSIONAL FLOWS THROUGH CASCADES
Ramani Mani Jul. 1967 48 p refs
(Contract Nonr-220(59))
(E-79-10; AD-656428)

Details are given of a procedure to compute the effect of varying axial velocity on the cascade performance of an axial flow compressor blade row. The relevant equations and the procedure of solution are given. Details are given of a computing program to carry out the calculations. The program is written in Fortran IV and is in three parts. Data cards giving details of the flow geometry have to be punched for the first part only. Author (TAB)

N67-37272# Harvard Univ., Cambridge, Mass. Lyman Lab.
SPECIFIC VOLUMES OF WATER AT HIGH PRESSURES OBTAINED FROM ULTRASONIC-PROPAGATION MEASUREMENTS
Rajagopalan Vedan and Gerald Holton 31 Jul. 1967 42 p refs *Its* Commun. No. 7
(Contract Nonr-1866(57))
(TR-3; AD-656400)

A computer-aided procedure was developed for obtaining specific volumes from measured ultrasonic velocities in any nondispersive medium. Newly measured velocities up to 80C and 10,000 kg/sq cm yielded values of specific volumes for water over this same range. P. W. Bridgman's measurements of specific volumes in the high-pressure range showed systematic differences of a few tenths of a percent; the present calculations yield values believed to be good to 0.050 or better. Author (TAB)

N67-37277*# Wyle Labs., Inc., Huntsville, Ala.
THE VISUALIZATION OF TURBULENT FLOWS BY MEANS OF FLOW BIREFRINGENCE
Eric B. Miller Jul. 1967 47 p refs
(Contract NAS8-5384)
(NASA-CR-88703; WR-67-12) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Flow birefringence is discussed as a technique for the qualitative investigation of separated flows. The results of high speed motion picture studies of unsteady flows through various geometries are discussed. Photographs of many of the observed phenomena are also presented. Recommendations are made for the design of an optimum flow system. It is concluded that the technique is of great value qualitatively and holds promise for development into a quantitative method for studying unsteady flows. An approach is suggested whereby the birefringent visualization of two dimensional flows could be extended more readily to three dimensional flows. Further study into the relationships between large eddies in turbulent shear regions and the associated mean flow properties is recommended. Author

N67-37310 Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Porz (West Germany). Institut fur Angewandte Gasdynamik.
ON THE MOTION WITHIN FLUID GYROSCOPES [UEBER DIE BEWEGUNG IN STROEMUNGSKREISELN]
M. Fiebig Apr. 1967 103 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-52; DVL-655)

The response of a sink flow through a cylindrical chamber to unsteady rotations of the chamber is investigated. The vector of rotation is along the chamber axis and the motion of the chamber is transmitted to the incoming flow by a porous wall. The flow is laminar and viscous but incompressible. A discussion of the different flow regimes as a function of the governing parameters is given. For flat chambers analytical results are given when the circulation is small compared to the sink strength. A visco-geometric similitude holds, except for the immediate neighbourhood of the chamber axis. The results show that such a device may be used to detect small angular motions of the chamber, and in this sense it acts like a gyroscope. Author

N67-37328# Ballistic Research Labs., Aberdeen Proving Ground, Md.
AIR LIQUEFACTION BOUNDARIES EXPERIMENTALLY DETERMINED FOR THE BALLISTIC RESEARCH LABORATORIES' SUPERSONIC AND HYPERSONIC WIND TUNNELS
Maurice A. Sylvester Jun. 1967 44 p refs
(BRL-R-1367; AD-656445)

The boundaries for the onset of air liquefaction were experimentally determined. These boundaries indicate the regions where the liquefaction of air constituents has an effect on the flow properties in the test section. The boundaries were determined by making static and total head pressure measurements (with varying temperature) throughout the appropriate Mach and Reynolds number ranges of both the supersonic and hypersonic wind tunnels. The results show that air liquefaction occurs near the theoretical boundary (Clausius-Clapeyron) for Mach numbers 4.75 and 5.00 with little, if any, supersaturation. However, as the Mach number increases to 6.0, 7.5 and 9.2, there is an increase in the amount of supersaturation before liquefaction occurs, and at a given Mach number, the difference between the experimental and theoretical temperature at the onset of liquefaction is about the same at all pressure levels tested. These results may allow a relaxation of our stagnation temperature requirements by an amount which would be of cqnsiderable operational significance at M = 9.2. Author (TAB)

N67-37349# Aix-Marseilles Univ. (France). Institut de Mecanique des Fluides.
EXPERIMENTAL STUDY AT MACH 7 OF THE EFFECTS ON THE PARIETAL THERMAL FLOW AND ON THE SHAPE OF THE SHOCK WAVE OF THE BLUNTING OF A NARROW-OPENING CONE [ETUDE EXPERIMENTALE A M 7 DES EFFETS DUS A L'EMOUSSEMENT D'UN CONE DE FAIBLE OUVERTURE SUR LE FLUX THERMIQUE PARIETAL ET SUR LA FORME DE L'ONDE DE CHOC]
31 Mar. 1966 106 p refs In FRENCH Prepared for O.N.E.R.A.
CFSTI: HC $3.00/MF $0.65

An experimental and theoretical study was conducted to reveal the viscous and nonviscous effects, due to blunting of the apex, on the flow around narrow-opening cones placed at various incidence settings in the Mach number 7 wind tunnel. The experimental study included determination of the density distribution of the convected heat flow and the pressure distribution on the surface of different slender-shaped obstacles. Measured flows were compared with the results of theoretical calculations based on the local similitude applied to the laminar boundary layer. Author (ESRO)

N67-37369*# Virginia Univ., Charlottesville. Research Labs. for the Engineering Sciences.
SCATTERING OF ARGON AND NITROGEN OFF POLYCRYSTALLINE NICKEL
R. G. Wilmoth (M.S. Thesis) and O. F. Hagena Aug. 1967 85 p refs
(Grant NGR-47-005-048)
(NASA-CR-88758; AEEP-4038-105-67U) CFSTI: HC $3.00/MF $0.65 CSCL 20D

An aerodynamic molecular beam and a sensitive time-of-flight detection system are discussed as means for measuring the distribution of flux and speeds of thermal-energy particles scattered from polycrystalline nickel surfaces. At room temperature, the distribution of reflected flux varies much as the cosine of the angle of reflection. Highly lobular flux distributions were observed after prolonged heating of the surface in a vacuum. Time-of-flight measurements indicate that for the speeds of the scattered particles thermal accommodation shows a strong dependence on the angle of reflection, and that the thermal spread is in general smaller than that of an effusive Maxwellian distribution at the surface temperature and is always larger than the spread in the incident velocities. A method of fitting analytic expressions to the measured time-of-flight curves provides a reasonably accurate means of obtaining the average speed and energy of the reflected particles. Author

N67-37374*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ISENTROPIC FLOW SOLUTIONS FOR REACTING GAS MIXTURES IN THERMOCHEMICAL EQUILIBRIUM
Ernest V. Zoby, Jane T. Kemper, and Casimir J. Jachimowski Washington, NASA, Oct. 1967 48 p refs
(NASA-TN-D-4114) CFSTI: HC $3.00/MF $0.65 CSCL 20D

A machine program is discussed that is developed for the calculation of local (edge of the boundary layer) pressure, density, temperature, enthalpy, entropy, the mole fractions of the chemical species, velocity, and the derivative of the velocity with respect to the pressure over a blunt body from given free-stream conditions. The local values are computed for arbitrary reacting ideal gas mixtures in thermochemical equilibrium with the assumption of isentropic flow and a given pressure distribution over the body. The associated normal shock and stagnation-point parameters are also computed. Excellent correlations are obtained with existing solutions for air at free-stream velocities from 2000 to 50,000 ft/sec (0.6096 to 15.24 km/sec) and altitudes up to 300,000 ft (91.44 km). Results for the normal-shock, stagnation-point, and local conditions based on an assumed Martian atmosphere are presented. The program was developed for the IBM 7094 electronic computer at Langley Research Center. The identification of the program inputs, a flow diagram, a listing of the species and the program, and a sample input and output are given in the appendixes of the paper. Author

N67-37409# Midwest Research Inst., Kansas City, Mo.
MASS SPECTROMETRIC STUDY OF HOMOGENEOUS NUCLEATION IN FREE JETS
Thomas A. Milne and Frank T. Greene 27 Jul. 1967 12 p refs Presented at the ASTM-E14 Mass Spectrometry Meeting, Denver, May 1967
(Contract Nonr-3599(00))
(AD-655292)

Free-jet expansions are being used to study the kinetics of the growth of clusters in highly supersaturated systems. A gas or gas mixture is expanded from high pressures into a vacuum to

form a free jet, which is then collimated into a molecular beam and introduced into the ion source of a mass spectrometer. The gases Ar, NO, N2, O2, CO2 and H2O, as well as the higher temperature species Hg, CsCl and Li, were examined. Some of the observed phenomena may be explained by the postulation of metastable dimers. Generalizations were attempted about the kinetics of cluster growth and about the conditions under which nucleation is apt to be important in beam formation and molecular beam sampling. Author (TAB)

N67-37410# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
A METHOD OF SELECTIVE DECOUPLING FOR ANALYZING NONEQUILIBRIUM FLOWS WITH APPLICATIONS TO ASYMPTOTIC SOLUTIONS FOR SHARP CORNERS
T. R. Sundaram Jun. 1967 94 p refs
(CAL-158)

Vibrational and dissociational nonequilibrium flows past sharp concave and convex corners are studied by using perturbation techniques. A method of selective decoupling has been developed whereby the relaxation rate equation is uncoupled from the fluid dynamic equations after rewriting it in a form suitable for exploiting certain inherent properties of the specific flow under consideration. The results of the above theory are also used to obtain a description of the entropy layer present close to the wall of the geometries considered. Because of the presence of the entropy layer, the asymptotic wall values of all the flow variables, with the exception of the pressure, are different from the infinite reaction rate equilibrium values. The final asymptotic values of the flow variables are found by calculating the increase in entropy along the streamline and by making use of the fact that the asymptotic pressure is insensitive to nonequilibrium effects. The asymptotic values obtained using the above technique are shown to be in good agreement with those obtained from exact numerical calculation for both concave and convex corners. Author

N67-37456# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
BURNETT EQUATIONS AND SHOCK STRUCTURE
Prem K. Khosla May 1967 34 p refs
(Contract Nonr-839(34))
(PIBAL-988; AD-656575)

The Chapman-Enskog expansion for the solution of the Boltzmann equation was re-examined and certain inconsistencies in the procedure were pointed out. For a steady state one-dimensional Boltzmann equation, the expansion is modified with the help of the PLK method. Macroscopic equations up to Burnett level of approximation are then obtained. Finally, these equations are used to examine the structure of a shock wave in a gas consisting of Maxwellian molecules. It is shown that new Burnett equations give solutions for all values of Mach number. Author (TAB)

N67-37468*# Southwest Research Inst., San Antonio, Tex.
NOTES ON THE DISCRIMINATION OF FREE-SURFACE MODES IN A CYLINDRICAL TANK
John F. Dalzell May 1967 43 p refs
(Contract NAS8-20319; SwRI Proj. 02-1869)
(NASA-CR-88518; TR-3) CFSTI: HC $3.00/MF $0.65 CSCL 20D

The problem of discrimination of certain cylindrical tank modes of free surface motion arose in the course of an exploratory investigation of the behavior of the fluid in tanks under random excitation. This problem is treated herein for discrimination of symmetric and antisymmetric modes, and several designs for specialized free surface measuring systems are presented. Author

N67-37521# Advisory Group for Aerospace Research and Development, Paris (France).
FLUID PHYSICS OF HYPERSONIC WAKES, VOLUME 2
May 1967 477 p refs In FRENCH and ENGLISH Papers presented at the AGARD Fluid Dyn. Panel Specialists' Meeting, Fort Collins, Colo., 10–12 May 1967
(AGARD-CP-19, Vol. 2) CFSTI: HC $3.00/MF $0.65

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13. BOUNDARY-LAYER PHENOMENA OBSERVED ON THE ABLATED SURFACES OF CONES RECOVERED AFTER FLIGHTS AT SPEEDS UP TO 7 km/sec T. N. Canning, M. E. Wilkins, and M. E. Tauber (NASA Ames Res. Center) 47 p refs (See N67-37534 22-33)

N67-37522# General Electric Co., Philadelphia, Pa. Missile and Space Div.
EXPERIMENTAL STUDIES OF TURBULENCE CHARACTERISTICS IN THE HYPERSONIC WAKE OF A SHARP SLENDER CONE
A. G. Boyer and E. P. Muntz *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 2 May 1967 31 p refs (See N67-37521 22-12)

An experimental investigation was conducted in a hypersonic shock tunnel and employed a new application of the electron

beam excitation technique to measure directly the scale and velocity of the turbulent density and temperature fluctuations, and to monitor their axial history in the wake of a sharp 10° half-angle cone model free flying in a Mach 12.6 flow. The beam technique incorporates a linear deflection system at the exit orifice to sweep the electron beam in the axial flow direction. The beam is collected in a special elongated receiver of precise dimensions which also serves as a timing device to accurately measure the axial velocity of the sweeping beam from the collected beam current waveform. All the tests were run at the same conditions: M = 12.6; stagnation temperature of 1200°K, freestream Reynolds number of 1.3×10^6/ft., freestream density equivalent to a pressure of 5.7 mm Hg at room temperature, and freestream velocity of 5660 fps. Dry nitrogen was used as the test gas. The flow thus closely approximated a perfect gas flow since nitrogen vibration is not significantly excited for these stagnation conditions. Author

N67-37523# Canadian Armament Research and Development Establishment, Valcartier (Quebec).
STUDIES OF TURBULENCE IN THE WAKES OF HYPERSONIC SPHERES UNDER SIMULATED REENTRY CONDITIONS
D. Ellington and G. Trottier *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 2 May 1967 36 p refs (See N67-37521 22-12)
(ARPA Order 133)

The techniques of cooled-film anemometry have been applied to the study of mean and fluctuating quantities in the hypersonic wakes of free flight spheres launched in the CARDE ranges. The measurements have yielded information on the temperature and velocity field over an extended length of wakes. Statistical analysis of this data in terms of correlation function and power spectral density has also been undertaken. This information is compared with results of measurements of other wake parameters such as mass and electron density. Author

N67-37524# Lincoln Lab., Mass. Inst. of Tech., Lexington.
SOME STATISTICAL PROPERTIES OF TURBULENT WAKES
J. Herrmann, W. G. Clay, R. E. Slattery, and R. E. Richardson *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 2 May 1967 27 p refs Sponsored by ARPA (See N67-37521 22-12)

Turbulent wakes of hypervelocity spheres launched from light gas guns at the Reentry Simulating Range have been studied by analyzing densitometer tracings of schlieren photographs. The correlation functions, spectral density, and variance of the turbulence of gas density in the wake of spheres of 3/16, 3/8 and 5/8 inch diameter, traveling at 20,000 fps, have been measured and compared with previous work on 8000 fps spheres. The statistical properties of the wakes are independent of pressure in the region of 10 to 80 torr and are independent of the position behind the sphere out to about 9000 body diameters. The wakes appear to be statistically homogeneous and isotropic, consistent with earlier measurements at lower velocities. The rms density fluctuations of the wakes peak further behind the bodies than is the case at lower velocities, although the three-dimensional spectrum of the gas density falls off with the same power dependence. Preliminary cross-correlation of the statistical properties of successive photographs of the same wake are presented. By this technique the ordered motion of the turbulence and its deceleration is measured. Author

N67-37525# Royal Aircraft Establishment, Farnborough (England). Space Dept.
PULSATIONS IN THE WAKES OF HYPERBALLISTIC SPHERES DURING ATMOSPHERIC RE-ENTRY
D. A. Spence, R. L. Dommett, and P. G. Smith (Roy. Radar Estab.) *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 2 May 1967 17 p refs Prepared jointly with Roy. Radar Estab., Malvern, Engl. (See N67-37521 22-12)

Two 17 inch diameter copper spheres were fired on the Woomera range as part of project Dazzle, and reentered the atmosphere almost vertically at speeds of 16000 ft/sec. Head-on VHF radar returns from the turbulent portions of the wakes showed marked periodicity in echoing cross section, corresponding to the successive formation of peak echoing areas at a frequency of approximately 5 cycles/sec. in a region several thousand diameters behind the head. These peaks, corresponding it is thought to sharp maxima in the local electron density distribution, drifted backwards along the wake at ambient velocity, decaying rather slowly until overtaken by the final electron loss mechanism. Their production frequency is two orders of magnitude lower than that corresponding to the Strouhal number for vortex shedding from the sphere, and it is suggested that they are due either to a surging process in the near wake or to a periodic breakthrough of the turbulent portion of the far wake into the surrounding entropy layer. Author

N67-37537# RAND Corp., Santa Monica, Calif.
PRACTICAL ASPECTS OF CALCULATING SKIN FRICTION COEFFICIENTS BY COLES THEORY OF COMPRESSIBLE TURBULENT FLOWS
J. L. Raymond and J. V. McGann-Lamar Jul. 1967 57 p ref
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5260-PR; AD-655766)

Coles theory for the turbulent boundary layer in a compressible fluid is used to compute curves of skin friction coefficient versus Reynolds number. The Mach numbers and wall-temperature ratios selected provide sufficient information for rapid estimation of turbulent skin friction drag for flat plates with zero pressure gradient. These results, though limited in scope and unverified experimentally for conditions outside the range of data originally considered by Coles, nevertheless provide the practicing aerodynamicist with a relatively simple means of estimating the flat-plate skin friction for airplane or missile components having compressible turbulent boundary layers. Coles theoretical hypotheses, partly based on experimental data, may be of significant value in improving upon the more exclusively empirical treatments of the past. While not difficult to interpret, Coles equations are mathematically complex and contain thought-provoking physical reasoning. In addition to the calculations of skin friction, the study includes a discussion of Coles classical theory and an interpretation of it for practicing aerodynamicists. The machine program for JOSS, The RAND Corporations on-line interactive computing system, is included. Author (TAB)

N67-37601# Advisory Group for Aerospace Research and Development, Paris (France).
FLUID PHYSICS OF HYPERSONIC WAKES, VOLUME 1
May 1967 498 p refs In FRENCH and ENGLISH Papers Presented at the AGARD Fluid Dyn. Panel Specialists' Meeting, Fort Collins, Colo., 10–12 May 1967
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6. INVESTIGATION OF THE BOUNDARY LAYER AND OF THE NON-VISCOUS WAKE, ON SHARP AND BLUNTED CONES AT INCIDENCE, IN HYPERSONIC FLOW J. Valensi, R. Guillaume, D. Guffroy, B. Roux, and J. Marcillat (Aix-Marseilles Univ.) 31 p refs (See N67-37607 22-12)

7. REYNOLDS NUMBER EFFECTS IN THE NEAR WAKE BEHIND A WEDGE AT SUPERSONIC AND HYPERSONIC SPEEDS W. F. Merzkirch (Freiburg Univ.) 22 p refs (See N67-37608 22-12)

8. STUDY OF WAKES BEHIND CYLINDERS AND WEDGES IN RAREFIED GAS FLOW P. Trepaud, R. Pery, J. P. Boehler, H. Viviand, and E. A. Brun (Centre Natl. de la Recherche Scientifique) 34 p refs (See N67-37609 22-12)

9. AN EXPERIMENTAL INVESTIGATION OF BASE MASS INJECTION ON THE LAMINAR WAKE BEHIND A 6-DEG. HALF-ANGLE WEDGE AT M=4.0 R. L. Chapkis, J. Fox, I. Hromas, and L. Lees (TRW Sys.) 31 p refs (See N67-37610 22-12)

10. RADIAL AND AXIAL VELOCITY PROFILES OF HYPERSONIC AND SUPERSONIC WAKES MEASURED BY THE SEQUENTIAL SPARK METHOD C. Lahaye, E. G. Leger, and A. Lemay (Canadian Armament Res. and Develop. Estab.) 36 p refs (See N67-37611 22-12)

11. AN EXPERIMENTAL STUDY OF THE PRESSURE AND HEAT TRANSFER ON THE BASE OF CONES IN HYPERSONIC FLOW E. J. Softley and B. C. Graber (GE) 36 p refs (See N67-37612 22-12)

12. HYPERSONIC INVESTIGATIONS ON THE LOCAL AND AVERAGE HEAT TRANSFER IN CAVITIES AND AFTER STEPS OF BODIES OF REVOLUTION W. Wyborny, H.-P. Kabelitz, and H.-J. Schepers (Deutsche Versuchsanstalt fur Luft- und Raumfahrt) 34 p refs (See N67-37613 22-33)

13. SOLUTION OF THE TIME-DEPENDENT NAVIER-STOKES EQUATIONS FOR THE FLOW OF DISSOCIATING GAS OVER A CIRCULAR CYLINDER S. M. Scala and P. Gordon (GE) 63 p refs (See N67-37614 22-12)

14. MASS DENSITY MEASUREMENTS IN HYPERSONIC WAKES J. G. G. Dionne, C. M. Sadowski, L. Tardif, and J. E. H. Vanoverschelde (Canadian Armament Res. and Develop. Estab.) 30 p refs (See N67-37615 22-12)

N67-37602# General Motors Corp., Santa Barbara, Calif. Aerophysics Section.

KINETIC PROCESSES IN HYPERSONIC WAKES

Alan Q. Eschenroeder *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 51 p refs (See N67-37601 22-12)

(Contract DA-01-021-AMC-11359(Z); Proj. Defender)

Chemistry, ionization, and energy transfer processes are considered for hypersonic wake flows, with emphasis on pure air processes for both blunt and slender body shapes and on the influence of microscopic gas phase behavior on the observable features of the wake. Active coupling with flow, blunt and slender body wake kinetics, kinetic models for neutral air species are reviewed. Electron decay mechanisms, along with wake ionization and kinetic models are also discussed; and attention is given to energy transfer processes, ablation effects, interactions between turbulence and chemistry. It is stressed that turbulence problems appear in more complicated forms whenever kinetics enters into the picture. M.W.R.

N67-37603# Princeton Univ., N. J. Gas Dynamics Lab.

DIAGNOSTIC STUDIES OF LAMINAR HYPERSONIC CONE WAKES

E. M. Murman, C. W. Peterson, and S. M. Bogdonoff *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 36 p refs (See N67-37601 22-12)

(Contract Nonr-1858(37))

Laminar hypersonic wakes behind conical bodies was studied in a conventional wind tunnel at Mach number 16 and in a free stream Reynolds number of 120,000/inch. A magnetic suspension system capable of supporting axisymmetric bodies was used, and helium at a stagnation temperature of 525°R was the test gas. Pitot pressure probes, hot-wire anemometry, and conventional static pressure probes were used. For the pitot pressure probes, the viscous wake behind the body was actually larger than the body base diameter; and no throat was present. This extensive spread of the wake is attributed to the expansion of the highly vortical boundary layer upon separation from the body. M.W.R.

N67-37604# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

WAKE MEASUREMENTS BEHIND A CONE SUSPENDED MAGNETICALLY IN A MACH NUMBER 4.3 STREAM

F. K. Browand, M. Finston, and D. K. McLaughlin *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 43 p refs (See N67-37601 22-12)

(Contracts AF 49(638)-1328; AF 33(616)-7023; AF 33(615)-1470)

Continuous pitot pressure is described behind a 7° half-angle cone at zero angle of attack and at recovery temperature. The pitot pressure surveys extend from the base to a distance of about 6 diameters downstream and are sufficiently detailed to accurately indicate the complete geometry of the near wake region including the corner expansion, lip shock, free shear layer, and wake recompression. Reynolds number dependence of the near wake characteristics and on body size effects is considered. These data are supported by Schlieren photographs of the near wake, although the photographs are of poorer quality than those usually obtained in ballistic ranges. Similar results are presented for the 7° cone at small angles of attack, which forcefully illustrate the sensitivity of the wake flow to this variable. The magnetic suspension system and the data acquisition techniques are described. Author

N67-37605# France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

EXPERIMENTAL ANALYSIS OF THE NEAR WAKE OF A SLENDER BODY FREE OF ALL LATERAL SUPPORT [ANALYSE EXPERIMENTALE DE PROCHE SILLAGE D'UN CORPS ELANCE LIBRE DE TOUT SUPPORT LATERAL]

M. Sirieix and J. Delery *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 45 p refs In FRENCH; ENGLISH summary (See N67-37601 22-12)

Methods developed for the study of near wake in a slender body are discussed, including an upstream aerodynamically-shaped holder passing through the nozzle throat that permits investigation of the wake in a turbulent state and in a uniform flow. Since this device was unable to accurately reproduce the state of flow around a true missile in the body-base plane, a magnetic model mounting with a telemetry device was used at Mach number 5 and for a wide range of Reynolds numbers. Results are presented for various forward body configurations; dead water structure, including a speed profile study in the recompression zone and the near wake; and transition development within the wake of a high aspect ratio slender body. Near wake studies dealing with reattachment conditions for a supersonic jet continue. M.W.R.

N67-37606# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Aerospace Engineering.
NEAR WAKE OF A SLENDER CONE IN HYPERSONIC FLOW
Edward M. Schmidt and Robert J. Cresci *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 31 p refs (See N67-37601 22-12)
(Contract Nonr-839(38))

The flow field in the near wake region of a slender cone in hypersonic free stream flow was investigated on a sharp 10° half-angle cone with an 8-in base diameter. Some profiles of pitot and static pressure in the near wake of a cone at angle attack are included, along with observations of the overall effects on pressure recovery. The Mach number 6 data for fully turbulent flow indicate that the effect of angle attack on the inviscid flow increases the stagnation pressure ratio by a factor of about three, and at Mach number 7 the increase is by a factor of five above the laminar axisymmetric flow conditions. This increase attributed to both the inviscid flow field over the cone and to the local alteration of the boundary layer on the cone surface resulting from the change from a laminar to a transitional condition. M.W.R.

N67-37607# Aix-Marseilles Univ. (France). Institut de Mechanique des Fluides.
INVESTIGATION OF THE BOUNDARY LAYER AND OF THE NON-VISCOUS WAKE, ON SHARP AND BLUNTED CONES AT INCIDENCE, IN HYPERSONIC FLOW
Jacques Valensi, Raymond Guillaume, Daniel Guffroy, Bernard Roux, and Jacques Marcillat *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 31 p refs (See N67-37601 22-12)

Sharp and blunted cones at incidence are investigated in hypersonic flow, which concerns the boundary layer flow especially near the base, as well as the nonviscous region between the bow shock and the body boundary layer. Boundary layer transition occurs when the incidence is smaller than the semiangle of the cone for the part of the surface least inclined to the wind. The transition appears to be due to an inflection in the shape of the boundary layer velocity profile. The measured values of pressure, density and heat transfer rate, are in excellent agreement with those calculated by three-dimensional laminar or turbulent boundary layer theory. For sharp cones, when the incidence exceeds the cone semiangle, separation of boundary layer is observed with the formation of two vortexes from the apex. The vortexes are also observed on blunted cones when the incidence is very small, and transition can occur in nonseparated regions when the thickness of the boundary layer is a maximum. Author

N67-37608# Freiburg Univ. (West Germany). Ernst-Mach-Institut.
REYNOLDS NUMBER EFFECTS IN THE NEAR WAKE BEHIND A WEDGE AT SUPERSONIC AND HYPERSONIC SPEEDS
Wolfgang F. Merzkirch *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 22 p refs (See N67-37601 22-12)

Base pressure, wake angle, and pitot profiles of near wakes behind a wedge in hypersonic helium flow were strongly influenced by Reynolds number. The two-dimensional wedge-shaped model permitted optical visualization of the free shear layer in the near wake, and a discrepancy between measured base pressure and visualized wake angle is attributed to body boundary layer expansion into a wide fan of diverging streamlines in the near wake. Reynolds number influence on near wake characteristics is attributed to factors such as mixing and diffusion in the free shear layer, interaction with recirculating dead air, viscous interaction with the recompression process at the wake neck, and nonisentropic expansion of the body boundary layer and consequent formation of a lip shock. A simplified model is used to describe the lip-shock formation at supersonic speeds, and to show dependence on Reynolds number. The small Mach angles and the geometry of the near wake at hypersonic speeds, however, do not allow for the development of lip-shock; and the strong viscous interactions come into play. M.W.R.

N67-37609# Centre National de la Recherche Scientifique, Meudon (France). Laboratoire d'Aerothermique.
STUDY OF WAKES BEHIND CYLINDERS AND WEDGES IN RAREFIED GAS FLOW [ETUDE DE SILLAGES DE CYLINDRES ET DE DIEDRES EN ECOULEMENT DE GAZ RAREFIE]
P. Trepaud, R. Pery, J. P. Boehler, H. Viviand, and E. A. Brun *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 34 p refs In FRENCH; ENGLISH summary (See N67-37601 22-12)

Results are presented for an experimental study of wakes behind cylinders and wedges (total angle = 10°), at Mach number 4, in rarefied gas flow. Reynolds number are 533 and 870 for the cylinder and 2540 for the wedge. Measurements are made with a pitot tube and a hot wire. The results show that the near wake has lost the well-defined structure found at high Reynolds numbers. Viscous effects make the wake characteristics more diffuse as the Reynolds number decreases more rapidly for the wedge than for the cylinder. Measurements of surface pressure and base pressure were made at Mach numbers 2 and 4, and at Reynolds numbers from 34 to 1400 for the cylinder and 137 to 2660 for the wedge. Author

N67-37610# TRW Systems, Redondo Beach, Calif.
AN EXPERIMENTAL INVESTIGATION OF BASE MASS INJECTION ON THE LAMINAR WAKE BEHIND A 6-DEG. HALF-ANGLE WEDGE AT M=4.0
Robert L. Chapkis, Jay Fox, Leslie Hromas, and Lester Lees *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 31 p refs (See N67-37601 22-12)
(Contract AF 04(694)-638)

Tests performed in the 20-inch supersonic wind tunnel, to determine the effects of injecting nitrogen through the base of a wedge show that dramatic and significant changes to the wake structure are caused by a relatively small rate of injection. Tests were at Mach number 4.0, a Reynolds number per inch of about 0.25×10^5, and stagnation temperature of about 100°F; and the wake behind the model was laminar for at least eight inches (the maximum distance available). The model is a 6° half angle wedge with a one-inch high porous base through which gaseous nitrogen can be injected; and it has cooling passages through which liquid nitrogen can be circulated to permit testing with either adiabatic or very cold-wall conditions. The basic measurements made in the wake were pitot pressure, wake-centerline static pressure, and hot-wire anemometer measurements. The hot wire was used primarily as a device for obtaining mean flow quantities, not fluctuating quantities. The hot-wire-data, corrected for end loss effects, were used in conjunction with the pressure data to determine all of the flow quantities in the wake. Author

N67-37611# Canadian Armament Research and Development Establishment, Valcartier (Quebec).
RADIAL AND AXIAL VELOCITY PROFILES OF HYPERSONIC AND SUPERSONIC WAKES MEASURED BY THE SEQUENTIAL SPARK METHOD
C. Lahaye, E. G. Leger, and A. Lemay *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 38 p refs (See N67-37601 22-12)
(ARPA Order 133)

Use of a sequence of sparks for velocity profile measurements across the wake of hypersonic projectiles is described, and the data reduction method is outlined for a particular case. Measured radial velocity profiles in wakes of hypersonic (15,000 fps) and supersonic (4,000 fps) sphere are presented for various positions in the wake and for various ballistic range pressures. The axial profiles constructed from these radial profiles are compared with the available theoretical estimates and measurements obtained using other methods. Author

N67-37612# General Electric Co., Philadelphia, Pa. Missile and Space Div.

AN EXPERIMENTAL STUDY OF THE PRESSURE AND HEAT TRANSFER ON THE BASE OF CONES IN HYPERSONIC FLOW

E. J. Softley and B. C. Graber *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 36 p refs Sponsored by AF (See N67-37601 22-12)

Base pressure and heat transfer on flat based 9° cones were measured in a hypersonic shock tunnel with free stream Mach numbers between 12.6 to 20. Independent variations of Reynolds number and wall temperature ratios were made at $M_\infty = 12.6$. Nose bluntness varied from "sharp" ($R_N/R_B < .005$) to $R_N/R_B = 0.3$. Only limited angle of attack effects were noted. In all cases the boundary layer on the cone surface was laminar. Measurements made in both conical and parallel flow facilities showed differences in the starting time of the wake flow. In the short conical nozzle with a model size of 2-in base diameter, wake flows were steady in approximately 1 millisecond. In the 22-in parallel flow nozzle, with a 4-1/2-in base diameter model, the flows took 4 milliseconds to become steady. The base pressure measurements are in general agreement with the flow field measurements of the electron beam. The extreme effects near the corner support arguments that viscous flow at separations from the body cannot be calculated using boundary-layer assumptions. Author

N67-37614# General Electric Co., Philadelphia, Pa. Missile and Space Div.

SOLUTION OF THE TIME-DEPENDENT NAVIER–STOKES EQUATIONS FOR THE FLOW OF DISSOCIATING GAS OVER A CIRCULAR CYLINDER

S. M. Scala and P. Gordon *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 63 p refs (See N67-37601 22-12)
(Contracts Nonr-4869(00); DA-49-083-OSA-3135)

Numerical solutions are presented for the complete time-dependent Navier–Stokes equations for a two-dimensional flow. Transient hypersonic flow around a right circular cylinder, including finite reaction rate chemistry for the dissociation of a diatomic gas is treated, along with the mathematical question of convergence. Numerical solutions were obtained on both IBM 7094 and CDC 6600 digital computers for the hypersonic flow around a right circular cylinder for a range of Reynolds numbers $1 < Re < 1000$. In these computations, the free stream velocity was held fixed at 20,000 ft/sec, and the Reynolds number was varied by changing the free stream density (simulated altitude) and the cylinder radius. Author

N67-37615# Canadian Armament Research and Development Establishment, Valcartier (Quebec).

MASS DENSITY MEASUREMENTS IN HYPERSONIC WAKES

J. G. G. Dionne, C. M. Sadowski, L. Tardif, and J. E. H. Vanoverschelde *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 30 p refs (See N67-37601 22-12)
(ARPA Order 133)

Mean and fluctuating mass density measurements were made in hypersonic wakes over a wide range of ambient densities. An electron beam probe was found suitable at pressures of from 1–10 torr. The mass density was related to the fluorescent intensity resulting from the collisions between the highly energetic electrons and the wake molecules. At ambient pressures above 10 torr, mean mass densities were measured using a laser probe. The intensity of the Rayleigh scattered light measured at an angle of 90° to the incident beam was related in a simple way to the local wake density. Both methods were characterized by their capabilities of good spatial and temporal resolution. Measured mean radial density distributions at several downstream positions, as well as power spectra of the fluctuations are presented. The fluorescence spectra excited in air and nitrogen by electron bombardment at energies ranging from 25 to 75 kilo electron volt are discussed. Author

N67-37636# Texas Univ., Austin. Defense Research Lab.

CALIBRATION OF SKIN FRICTION BALANCE DISCS FOR PRESSURE GRADIENT

Harold U. Everett Aug. 1958 54 p refs
(Contract NOrd-16498)
(DRL-426; CF-2708; AD-655414)

The effect of a pressure gradient on skin friction balance measurements in channel flow was investigated. Three channel heights and four disc configurations were employed. A proposed correction for pressure drag on the skin friction balance disc was found to yield satisfactory agreement between measured apparent stress and theoretical apparent stress for optimum disc configuration. Author (TAB)

N67-37675# General Applied Science Labs., Inc., Westbury, N. Y.

INVERSE COMPUTATION OF SUPERSONIC INVISCID FLOW FIELDS WITH IMBEDDED SHOCKS: ANALYSIS AND USER'S MANUAL

Michael Abbett 30 Nov. 1966 83 p
(Contract AF 33(615)-2568)
(TM-156; AD-655806)

A program was developed to compute the steady supersonic flow field of an inviscid, non-homenergetic, non-homentropic, compressible, calorically and thermally perfect gas which may or may not have imbedded shocks. The flow field may be either two-dimensional or axisymmetrical (without swirl). The inception of imbedded shocks is detected by the coalescence of characteristics. In addition to computing the creation and development of several such shocks of the same family, the program computes the interaction and continuation of these shocks when they intersect. A maximum of five such shocks can be handled simultaneously, although this limit can be considerably increased with minor modifications. Author (TAB)

N67-37725# Johns Hopkins Univ., Baltimore, Md. Dept. of Mechanics.

ON THE ASYMPTOTIC FORM OF THE STREAM FUNCTION FOR THE FLOW OF AN OSEEN-LIKE FLUID PAST A PARABOLIC CYLINDER

Carl Kaplan Jun. 1967 32 p ref
(Contract AF 49(638)-1303)
(AFOSR-SR-67-1346; AD-655894)

The asymptotic behavior of the flow at a large distance from a parabolic cylindrical obstacle immersed in the uniform flow of an incompressible viscous fluid is considered on the basis of a successive approximation method, with the Oseen solution as the

first step. Only dominant terms are retained in the expression for the stream function. Four steps in the approximation procedure yield a parabolic displacement surface which for the degenerate case, namely, the semi-infinite flat plate, approaches very closely the Blasius result and thus demonstrates the validity of the Oseen type of successive approximations in dealing with the Navier-Stokes equations. Author (TAB)

N67-37728# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.

CAVITATION NUCLEATION BY ENERGETIC PARTICLES

C. West Jun. 1967 23 p refs

(AERE-R-5486) HMSO: 3s 6d

Some recent work on neutron induced cavitation is reported. A brief description is given of the apparatus used to generate a high amplitude ultrasonic field, and of the electronic system. In addition to experiments using an isotope source of neutrons (both slow and fast), some preliminary work with a pulsed D–T generator is described. The problem of nucleation by radiation is discussed and the differences between bubble chambers (where Seitz's theory has been applied with considerable success) and cavitation are outlined. An alternative approach which becomes identical with Seitz's theory for the positive pressure bubble chamber case is considered. Agreement with existing experimental data is improved, but remains quantitatively poor. Author

N67-37734# Stanford Univ., Calif. Dept. of Mechanical Engineering.

HYDRODYNAMIC STABILITY OF THE LIQUID LAYER ON A SMALL OBJECT IN HIGH ALTITUDE REENTRY

W. C. Reynolds Albuquerque, N. Mex., Sandia Corp., Jun. 1967 44 p refs

(SC-CR-67-2636) CFSTI: HC $3.00/MF $0.65

The hydrodynamic instabilities relevant to a thin liquid layer on a small body reentering the atmosphere are reviewed. An analysis is presented for the case of a liquid layer subjected to an impinging hypersonic free molecule flow. The Craik–Benjamin instability mechanism is found to be quite important. A simplified estimate is given for the conditions under which a small body may be expected to survive reentry without melt layer removal. Author (NSA)

N67-37736* Farnham (Frank C.) Co., Philadelphia, Pa.

SHOCK WAVES FAR FROM THEIR SOURCE [OB UDARNYKH VOLNAKH NA DALEKIKH RASSTOYANIYAKH OT MESTA IKH VOZNIKNOVENIYA]

L. Landau Washington, NASA, Sep. 1967 10 p ref Transl. into ENGLISH from Prikl. Mat. i Mekh. (Moscow), v. 9, no. 4, 1945 p 286–292

(Contract NASw-1497)

(NASA-TT-F-11246) CSCL 20D

This study demonstrates that at large distances from a body moving at a supersonic velocity, there exist two shock waves which follow each other, rather than one wave, as has been supposed. The shapes of these waves and the law of decrease of their intensity are determined. The propagation of spherical shock waves (explosion waves) at large distances from the point of explosion also is investigated. Author

N67-37763# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

TRANSONIC FLOWS IN THE NEIGHBORHOOD OF A POINT WHERE A SHOCK WAVE MEETS THE SONIC LINE

Paul Germain and Georges Gillon 16 May 1967 39 p refs Transl. into ENGLISH from the French Presented at the 10th Intern. Congr. of Appl. Mech., Stresa, 31 Aug.–7 Sep. 1960

(Contract NOw-62-0604-c)

TG-230-T520; AD-655457)

The general outlines of the theory of homogeneous transonic flows are reviewed. Then it is shown how this theory may be applied to study of the singular behavior of a transonic flow close to a place where a shock meets a sonic line. Some examples are worked out in detail in order to show what kinds of singularities may arise in the midst of such flows. Author (TAB)

N67-37771*# Southwest Research Inst., San Antonio, Tex.

EXPLORATORY STUDIES OF LIQUID BEHAVIOR IN RANDOMLY EXCITED TANKS: LONGITUDINAL EXCITATION

John F. Dalzell May 1967 73 p refs

(Contract NAS8-20319)

(NASA-CR-88533; TR-1) CFSTI: HC $3.00/MF $0.65 CSCL 20D

This report presents results obtained in an exploratory investigation of the behavior of fluid in a cylindrical tank under relatively low frequency random longitudinal excitation. It was found that large amplitude nonlinear free surface response is possible under some conditions of random excitation. Though quantitative data on free surface elevations were obtained only on the tank axis, the results strongly indicate that the large amplitude fluid response is of the 1/2 subharmonic type observed under harmonic excitation. Data on the probability structure of the nonlinear free surface response are also presented. Author

N67-37815# Massachusetts Inst. of Tech., Cambridge. Fluid Dynamics Research Lab.

AN APPROXIMATE SOLUTION OF THE BOUNDARY LAYER EQUATIONS USING THE METHOD OF PARAMETRIC DIFFERENTIATION

David C. Ines Jun. 1967 139 p refs

(Contract AF 49(638)-1622)

(T67-1; AFOSR-67-1512; AD-656693)

A study was made of the boundary layer problem, using the method of parametric differentiation. The boundary layer flow is assumed to be laminar, steady, two-dimensional, and incompressible, with no heat transfer, suction or blowing. Two methods of parametric differentiation were utilized: the first varied the outer inviscid flow; while the second varied the velocity slip at the wall. The method of parametric differentiation is well suited to solve the non-linear boundary layer equations. A related linear partial differential equation, coupled with a first order ordinary non-linear differential equation, is produced by the application of this method. A formal higher approximation procedure was developed to accurately solve the ensuing linear partial differential equation, replacing the local solution approximation used heretofore. This higher approximation procedure is couched in terms which allow the application of asymptotic methods. The result of this analysis is an integral equation describing the rate of change of the velocity field with respect to a parameter. Author (TAB)

N67-37839 Lockheed Missiles and Space Co., Sunnyvale, Calif.
GENERALIZED EQUATION TO DETERMINE THE TANGENTIAL STRESSES ON THE WALLS OF A TUBE DURING UNSTEADY VISCOUS FLUID MOTION
D. N. Popov [1967] 5 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Mashinostro. (Moscow), no. 5, 1967 p 52–57

For a general case an equation is derived to show the nonstationary value of the tangential stress on a tube wall depending on the law of variation of the fluid discharge in the tube. A generalized law for the tangential stress on a tube wall under unsteady fluid motion conditions is obtained as the transfer function. When the problem of the value of the tangential stress on a tube wall is solved, and the law of variation of this stress in the active section of the flow is not determined, the ordinary differential equation of infinite order may be utilized in place of the partial differential equation. This equation is considered to be of value in computer machine solutions. R.U.

N67-37923* Electro-Optical Systems, Inc., Pasadena, Calif.
ZERO-G LIQUID STUDIES: CRITICAL STATE AND DROP DYNAMICS
15 Aug. 1967 29 p
(Contract NAS8-21012)
(NASA-CR-88747; EOS-7170-Q-2) CSCL 20D

The densities studies experiment breadboard was designed and constructed, and investigations on the critical state are described. A temperature control system for the density studies experiment was tested with a thermal mockup. Its electronic performance was evaluated, and the data are graphed. Problems encountered with the free piston mercury volumeter and pressure measurement are discussed, and their solutions indicated. Apparatus and initial research are also reported on methods of inducing dynamic behavior in a liquid drop. These include drop forming through a capillary tube, drop spinning, and drop behavior in electrical and acoustical fields. N.E.N.

N67-37927*# Southwest Research Inst., San Antonio, Tex.
EXPLORATORY STUDIES OF LIQUID BEHAVIOR IN RANDOMLY EXCITED TANKS: LATERAL EXCITATION
John F. Dalzell May 1967 50 p refs
(Contract NAS8-20319)
(NASA-CR-88534; TR-2) CFSTI: HC $3.00/MF $0.65 CSCL 20D

This report presents results obtained in an exploratory investigation of the behavior of fluid in an unbaffled circular cylindrical tank under relatively low frequency random lateral excitation. It was found that swirl instability may occur under random excitation and a tentative basis for predicting this instability is advanced. Attempts were made to demonstrate the validity of the linear hypothesis for the unbaffled tank under low level random excitation, but the experimental evidence developed does not appear to validate this hypothesis within the experimental range of excitation levels. Brief, qualitative studies of non-stationary random excitation were carried out and are described. Author

N67-37960# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
MULTIPLE AND RAPID MEASURES OF PRESSURES IN A WINDTUNNEL [MESURES MULTIPLES ET RAPIDES DES PRESSIONS EN SOUFFLERIE]
Jacques Fiquet Apr. 1967 8 p Presented at the Mesucora Congr., Paris, 17–21 Apr. 1967
(TP-451)

Aerodynamic tests in wind tunnels are summarized, and zones of equal pressure are indicated. Schematics and photographs depict the scientific instrumentation used; this includes the liquid multimanometer and the pneumatic commutator. R.U.

N67-38009# Stanford Univ., Calif. Computer Science Dept.
ON COMPUTATION OF FLOW PATTERNS OF COMPRESSIBLE FLUIDS IN THE TRANSONIC REGION
Stefan Bergman, John G. Herriot, and Paul L. Richman 7 Jul. 1967 80 p refs
(Contract Nonr-225(37); Grant NSF GP-5962)
(CS-70; AD-655472)

Of interest to the study are the initial and boundary value problems for compressible fluid flow. The paper deals with the numerical solution of the initial value problem. TAB

N67-38018* International Information, Inc., Philadelphia, Pa.
EFFECT OF TRANSVERSE CURVATURE ON AXISYMMETRIC COMPRESSIBLE LAMINAR BOUNDARY LAYER
Jun-tao Shen and Tien-fun Sun Washington, NASA, Jun. 1967 30 p refs Transl. into ENGLISH from Acta Mech. Sinica (China), v. 9, no. 2, Jun. 1966 p 150–172
(Contract NASw-1499)
(NASA-TT-F-10970) CSCL 20D

The effect of the transverse curvature on the axisymmetric, compressible, laminar, boundary layer flow is discussed. The region of strong effect, where the boundary layer thickness is much larger than the local body radius, is considered. The usual assumptions of perfect gas are made. A small parameter ϵ is found to characterize the transverse curvature effect, which is investigated by means of the momentum integral method. Author

N67-38023 Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION OF THE TWO-DIMENSIONAL WALLJET
James H. Whitelaw Apr. 1966 52 p refs
(ARC-CP-942)

A new apparatus, designed to investigate the effects of slot geometry on the effectiveness of film cooling, is described and new measurements of the impervious wall effectiveness are presented. The measurements were performed in the range $2.4 \leq m \leq 0.47$ using helium as a tracer gas and gas chromatographic equipment to detect the relevant concentrations. The appropriate hydrodynamic quantities are reported in detail. Author

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N67-36752# Air Force Cambridge Research Lab., Bedford, Mass. Upper Atmosphere Physics Lab.

NEW MODEL ATMOSPHERES GIVING LATITUDINAL AND SEASONAL VARIATIONS IN THE THERMOSPHERE

K. S. W. Champion, F. A. Marcos, and J. Slowey Jun. 1967 35 p refs Presented at the 7th Space Sci. Symp. of COSPAR, Vienna, May 1966 *Its* Surv. in Geophys. no. 194
(AFCRL-67-0330; AD-655775)

A set of model atmospheres was prepared which constitutes a major advance in the representation of systematic variations in atmospheric properties between 120 and 250 km. The new models have three sets of boundary conditions at 120 km, which represent idealized variations with season and latitude, and connect with the new low altitude models which are a function of season and latitude. The three sets of high altitude models merge into one set above about 250 km. This set is identical with Jacchias latest models and is a function of the usual parameters, including time of day, solar flux and geomagnetic index. The new models appear to be in reasonable agreement with available experimental data. The theory predicts variations in the number densities of the individual constituents. An unexpected result is the prediction that the ratios of the constituents (such as O to O2) also vary, even at the boundary altitude. TAB

N67-36775# Northwestern Univ., Evanston, Ill. Dept. of Geology.

FORTRAN IV COMPUTER PROGRAMS FOR MARKOV CHAIN EXPERIMENTS IN GEOLOGY

W. C. Krumbein Jul. 1967 44 p refs Kansas Univ., Computer Contrib. No. 13
(Contract Nonr-1228(36))
(TR-6; AD-655447)

Probabilistic models provide a mechanism for computer simulation of a wide variety of geological processes. This paper emphasizes first-order Markov chains because of their intuitive appeal and rapidly growing applications. Examples are based on stratigraphic analysis, but other uses of the model are discussed briefly. First-order Markov chains are among the simplest stochastic process models, and they afford a point of entry into a large class of probabilistic mechanisms that can be useful in geology. This paper is designed to stimulate experimentation with these models, in part by providing relatively simple computer programs that cover four aspects of such analysis. These programs, listed in the Appendix, include one for testing the presence of a Markov property, a second for raising the transition probability matrix to successive powers in order to estimate the equilibrium states (i.e., the fixed probability vector) of a system, and a third for using the transition matrix in simulation studies. A fourth program for simulating independent-events processes (non-Markovian) can be used with the fixed probability vector of a Markov chain to obtain some interesting comparisons among different ways of structuring a sequence of observations or events. Author (TAB)

N67-36832# Stevens Inst. of Tech., Hoboken, N. J. Davidson Lab.

THE DIRECTIONAL SWELL SPECTRUM OFF BLOCK ISLAND

Paul H. Rank, Chester E. Grosch, Stephen J. Lukasik, and George W. Zepko Jun. 1967 65 p refs
(Contract Nonr-263(36))
(Rept.-1155; AD-655465)

An array of four pressure gauges was used to measure the swell off Block Island, Rhode Island. The data were analyzed to obtain the directional wave spectrum. Resulting directional information agreed with visual observations at the time of the experiment. TAB

N67-36840# Texas Instruments, Inc., Dallas. Science Services Div.

CRUSTAL STUDIES: CONTINUATION OF BASIC RESEARCH IN CRUSTAL STUDIES Final Report

Max K. Miller, A. Frank Linville, and Hugh K. Harris 15 Jul. 1967 118 p refs
(Contract AF 49(638)-1588; ARPA Order 292)
(AFOSR-67-1581; AD-656778)

The final report of work performed under the Crustal Studies Contract AF 49(638)-1588 is divided into two main areas: theoretical dispersion calculations and experimental measurements of the fundamental Rayleigh wave at the Large Aperture Seismic Array (LASA) in Montana, and a study of teleseismic signals using analog model data. Two earthquakes recorded on the long-period seismometers at LASA, were used for dispersion analysis. Epicenters of these two events were located off the northern California coast and in the Greenland Sea. Good agreement in the dispersion estimates was obtained using three recording stations. The significance of the results, which covered a frequency band of 0.025 through 0.0625 cps, lies in the fact that this frequency band is, theoretically, where the greatest dispersion occurs. The results obtained agree qualitatively with previously known results. An analog model having a crustal layer with an abrupt thickness change (3 to 5 cm) was used for studies of surface-wave scattering from surface irregularities and a lateral inhomogeneity. The analysis of surface-wave scattering was a continuation of work previously done. The model also was used for a study of teleseismic signals by placing the source crystal on the bottom of the model. For an upcoming-plane *P* wave, reverberation effects, the lateral inhomogeneity (including the expected focusing of energy into the thick end by the dipping segment of the crustal layer), and P- and S-wave conversions at the crustal layer interface caused a complex interference pattern that was observed on the surface recordings. Author (TAB)

N67-36880*# Columbia Univ., New York. Plasma Lab.

A THEORY OF GEOMAGNETIC MICROPULSATIONS

Amiya K. Sen Jan. 1967 73 p refs
(Grant NsG-302-63)
(NASA-CR-88515; Rept.-33) CFSTI: HC $3.00/MF $0.65 CSCL 08N

A theory of one of several possible mechanisms responsible for micropulsations is presented. A source mechanism at the boundary of the magnetosphere and its strong effect on the bandwidth and relatively small effect on the spectrum are discussed. The important role of the transmission path, including that in the outer magnetosphere, in determining the spectrum of micropulsation signals received at the surface of the earth is analyzed. The crucial role of the slightest variation of the path length in the outer magnetosphere (due to variations in the solar wind) on the spectrum is discussed. Sharp peaks in the amplitude spectrum are predicted at time periods $T \approx 935, 311, 134, 103, 71, 39, 14, 9, 7$ and 4. On the other hand, a crude analysis of power spectral density reveals spectral peaks at $T \approx 2.5, 6, 11$, and especially 20, with a slope of approximately 6db/octave at large time periods only. Author

N67-36881# Aeronautical Chart and Information Center, St. Louis, Mo. Chart Research Div.

ORIGIN OF THE CRIMEA AND BLACK SEA

S. A. Kovaleskiy Jul. 1967 11 p Transl. into ENGLISH from Priroda (Moscow), no. 3, 1966, p 108–113
(ACIC-TC-1215; AD-655706)

It is generally assumed that the Crimean mountains represent the remnants of a large mountain structure-anticlinorium, similar

to the Caucasus Mountains, destroyed during the formation of the Black Sea basin. Many geologists considered the Black Sea to be an area where the larger part of the Crimean anticlinorium was buried. Therefore they tried to find in the relief of the sea bottom traces of sunken mountains. However, such research provided no positive data, while recent geological works with the use of more and more perfect methods of rock analysis, detailed survey and abyssal boring, together with high level geophysical investigations discovered many structural details of Crimea and the Black Sea bottom, which cast a new light upon objects and facts which were considered to be already well known. TAB

N67-36896# Brown Univ., Providence, R. I. Dept. of Geological Sciences.
SPHERULES IN SEDIMENTARY ROCKS Final Report, 1 May 1966–30 Apr. 1967
Thomas A. Mutch May 1967 44 p refs
(Contract AF 19(628)-6008)
(AFCRL-67-0315; AD-655794)

Rock salts and cherts have been processed for recovery of magnetic spherules. An assumption of constant spherule influx throughout geologic time is compatible with actual spherule abundances both in rapidly deposited salts of Silurian, Permian and Triassic age and slowly deposited cherts of Jurassic age. Repeated small-area chemical analyses of spherule polished surfaces with an electron microprobe reveal no obvious segregation of phases. Two groups of spherules can clearly be distinguished. The first is made up chiefly of Fe with small amounts of Mn and Cr. The second group contains variable amounts of Fe, Si, K, Al, Ca, and Ti. Author (TAB)

N67-36900# University of Southern Calif., Los Angeles. Dept. of Geology.
SEDIMENTOLOGIC STUDIES OF THE COLORADO DELTA Final Report, Jul. 1964–30 Jun. 1966
Donn S. Gorsline Mar. 1967 121 p refs
(Contract Nonr-228(29))
(USC-GEOL-67-1; AD-655631)

The report reviews the work accomplished under the original contract including literature review, sedimentologic data analysis, and surficial characteristics of the Colorado Delta with emphasis on the lower portions of the delta. The Colorado is distinctive since it is a major delta built under highly arid climatic conditions. This special climatic setting produces a very different assemblage of surficial types with barren mud flats predominating, and salinas second in importance but with marshes a negligible type in contrast to most other major deltas such as that of the Mississippi River where marshes are the dominant surficial form. The lack of peat deposits may also contribute to the much less evident compaction subsidence of the delta and the relatively stable form of the feature since its first exploration some four centuries ago. A second unusual condition is that the delta is situated in the graben formed by one of the major active fault systems of the world. Thus faulting and active movement of a tectonic nature are the major influences on the form of the delta. Traces of scarps can be seen on aerial photographs of the deltaic plain. Several problems are evident for future research including a study of the clay mineralogy of this delta, particularly in areas of exceptionally high salinity; tectonic effects on sedimentation; and rates of accretion. TAB

N67-36923# Lockheed California Co., Burbank. Oceanics Div.
DEEP WATER INTERNAL WAVES STUDY Final Report, 7 Mar. 1961–31 Jul. 1967
Alfred J. Carsola 31 Jul. 1967 49 p refs
(Contract Nonr-3348(00))
(Rept.-20848; AD-655630)

Two arrays of thermistors were installed and operated off San Clemente Island, California, for several months in 1964 and from 5 August 1965 to 16 January 1966. For the latter array, thermistors at 240 and 340 were inoperative after 3 September 1965, but data are available for the thermistors at 1640 and 1740 from 5 August 1965 to 16 January 1966. Spectra of temperature fluctuations show little statistical energy at frequencies above 0.04 cycles per minute, corresponding to periods below 25 minutes. Only rarely was the frequency corresponding to 0.01C/cy/min greater than .006 cpm (period of 166 minutes or about 3 hours). Some peaks occasionally appear at frequencies higher than 0.04 cpm, but these are small and probably not significant. The spectra for the longest continuous records from 18 November to 27 December 1966 show two peaks, one at approximately 12 hours, and the other between 24 and 32 hours. Results of these experiments emphasize the dominance of tidal periods in thermal fluctuations and indicate that relationships between surface and internal tides should be clearly established. These results are in substantial agreement with those obtained by other investigators in the past decade. Author (TAB)

N67-36925# Navy Electronics Lab., San Diego, Calif.
A PREDICTIVE HORIZONTAL-TEMPERATURE-GRADIENT MODEL OF THE UPPER 750 FEET OF THE OCEAN Research Report, Jul. 1962–Jul. 1965
E. L. Smith 17 Mar. 1967 92 p refs
(NEL-1445; AD-655620)

Time-dependent horizontal-temperature gradients were computed from vertical-temperature cross sections taken with the towed thermistor chain in 17 areas of the eastern North Pacific. The horizontal gradients were found to be generally smaller than the vertical gradients by two orders of magnitude. The horizontal-gradient field alternated regularly in sign, implying a dominant frequency of internal waves or convection cells (with a corresponding wavelength of 0.72 nautical mile). The horizontal gradient in the thermocline can be predicted from the measured vertical gradient by means of the equation: $dT/dx = 0.0047(dT/dz)$ to the 0.71 power. On the basis of these results, plus a single bathythermograph lowering, a simplified predictive model of the horizontal-temperature gradients was constructed. Author (TAB)

N67-36937 Ionospharen-Institut Breisach (West Germany).
IONOSPHERE DATA, VERTICAL-ECHO-SOUNDING: FREIBURG, URSI-CODE 131 [IONOSPHAEREN-DATEN, VERTIKAL-ECHO-LOTUNG: FREIBURG, URSI-CODE 131]
Jul. 1967 44 p In GERMAN and ENGLISH
(Rept.-253-F)

The terminology is defined for the ionospheric characteristics and punchcard codes, the units, descriptive letters, and qualifying letters used. Tabulated data are presented on the measurements and median values for the E- and F-layers. M.G.J.

N67-36968# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
TIDAL NUMBERS AND PHASES AS DEDUCED FROM SATELLITE ORBITS
Robert R. Newton Apr. 1967 87 p refs
(Contract NOw-62-0604-c)
(TG-905; AD-655458)

The paper uses perturbations in the inclination and in the longitude of the node for four nearly polar satellites to find values of the tidal number k and of the phases for the lunar and solar semi-diurnal tides. In order to obtain the desired accuracy, it was necessary to include the following perturbations in the analysis: (1) differences between UT2c and UT1, (2) the motions of the true coordinate systems of date, including the rotation of the ecliptic, (3) atmospheric drag, (4) radiation pressure, including radiation scattered or emitted by the satellite and including radiation scattered

by the earth as well as direct sunlight, (5) the atmospheric tide, (6) the gravitational perturbations produced by the sun and moon, and (7) the perturbations due to the zonal gravity harmonics. For many of these existing perturbation procedures are not accurate enough, and new methods were devised. The new methods are described. By-products of the perturbation analysis include a small decrease in estimates of upper atmosphere wind velocities and a substantial increase in the estimated torque due to the atmospheric tide. The value found for the ratio of lunar to solar tidal friction torques is considerably greater than that given by any existing model, but is closer to the value generally given for linear friction than to that for non-linear friction. This does not imply that the friction is linear. It is shown that the relation between the torque ratio and the type of friction depends upon an unknown parameter of the oceans. Over a large range of this parameter, which includes plausible values, the ratio of the friction torques is independent of the law of friction. Author (TAB)

N67-37007# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
A REVIEW OF SEVEN PAPERS CONCERNING THE MEASUREMENT OF TEMPERATURE IN THE STRATOSPHERE AND MESOPHERE
Harold N. Ballard May 1967 82 p refs
(ECOM-5125; AD-656461)

Seven papers concerning the measurement of atmospheric temperature between the altitudes of 30 and 60 km were chosen for study. The spherical bead thermistor serves as the temperature sensing element in each case. The heat transfer equations which are common to all treatments are discussed. Each paper is then considered, giving the physical characteristics of each instrument and the values chosen by each investigator for the various heat transfer parameters. The resulting rates of energy transfer for each heat transfer process, as applicable to a particular instrument at 60 km, are listed with the corresponding temperature corrections. The total corrections to the temperature at 60 and 50 km are also listed. The conclusions of each investigator, as stated by the investigator, are included. A summary of all results is then presented. The correction values, as determined by each investigator, are arranged in tabular form so that they may be compared. In cases where the comparison indicates that there is a major difference in the value of a particular quantity, an opinion is given for the cause of the difference. Author (TAB)

N67-37027*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE ANALYSIS OF TOPSIDE IONOGRAMS
J. E. Jackson Sep. 1967 106 p refs
(NASA-TM-X-55925; X-615-67-452) CFSTI: HC $3.00/MF $0.65
CSCL 04A

Techniques are discussed which improved the accuracy of the Alouette II N-h (ionospheric electron density–altitude) analysis by an order of magnitude. The improved analysis is based on a parabolic-in-log-N lamination method, actual values of the geomagnetic field at all heights, a change in variable which renders the integrand finite at the reflection point, and iteration until successive calculations agree to within 0.01 km. A technique is described which insures and accelerates the convergence of the iteration process. The selection of data points is discussed and it is shown that accurate results can be obtained with 10 to 20 properly selected h'–f values. Care is needed in scaling the ionograms, particularly when critical portions of the traces are hidden by local resonance effects. Although N–h profiles are normally derived from the extraordinary trace, scaling accuracy can be improved by using all the information on the ionograms. Topside sounder parameters, capabilities, and limitations are discussed and illustrated with graphs showing the temporal and geographic coverage available. R.N.A.

N67-37041# General Electric Co., Philadelphia, Pa. Missile and Space Div.
TURBULENCE IN STRATIFIED ATMOSPHERE
C. M. Tchen Aug. 1967 29 p refs *Its* Tech. Inform. Ser. (R67SD45)

The spectral distributions of velocity and density fluctuations in a stratified atmosphere were investigated. The equations determining the two spectra contain the following transport functions: model transfer, production by shear, distabilization or damping by buoyancy, and acoustic diffusion. The method of cascade decomposition is applied to attack the nonlinear equations of momentum and continuity. Three cases are solved: (a) spectra by acoustic diffusion, (b) spectra by buoyancy damping, and (c) spectra by distabilizing buoyancy. The eddy viscosity, the eddy diffusivity, and the acoustic diffusion functions are derived. Author

N67-37049# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
SOME MECHANICAL PROPERTIES OF ALPINE SNOW, MONTANA 1964–66
C. M. Keeler and W. F. Weeks Mar. 1967 48 p refs
(CRREL-RR-227; AD-655528)

Data on the physical properties of seasonal alpine snow have been collected from the Beartooth Mountains near Cooke City, Montana, and the Bridger Range near Bozeman, Montana. Systematic measurements of snow density, temperature, structure, ram and Canadian hardness, centrifugal tensile strength and shear strength measured with a shear box and several types of shear vanes are included. Test results were grouped according to gross snow types and whether the snow was wet or dry. Interrelations between the different test parameters were studied. Experiments were also conducted to study the sources of error in making in-situ mechanical tests on snow without utilizing a pit wall. The main factor contributing to the experimental scatter is lateral inhomogeneity in the snow cover. However, the standard deviation of a group of strength tests is shown to be directly proportional to the mean value of the group. The systematic relations between snow properties invariably become obscured when different snow types are indiscriminantly grouped together. TAB

N67-37071 Defence Research Board, Ottawa (Ontario).
ALOUETTE I IONOSPHERIC DATA INTERPOLATED N(h), VOLUME 1
1 Aug. 1967 489 p

The electron number density at heights from 1000 km to 250 km in increments of 50 km are tabulated for the period from October 1962 through 1963. N.E.N.

N67-37087# Massachusetts Inst. of Tech., Cambridge. Geophysics Lab.
IONOSPHERIC PERTURBATIONS AND SCHUMANN RESONANCE DATA
Philip H. Nelson (Ph.D. Thesis) May 1967 123 p refs
(Contract Nonr-1841(75))
(AD-656761)

The properties of the first Schumann resonance mode are examined experimentally and theoretically to determine the influence of ionospheric disturbance events upon the electromagnetic earth-ionosphere cavity. On the experimental side, a phase-sensitive tracking system has been constructed to monitor the first mode peak frequency and Q on a continual basis. The tracking system monitored signals from a vertical antenna in eastern Massachusetts for five months during 1966-1967. On the theoretical side, a

study of the inverse problem was made. The results show that the short term resonance variations can be used to locate ionospheric perturbations. The transmission surface representation of the earth-ionosphere cavity is solved using a Greens function technique to obtain the cavity response to perturbed ionospheric models. An iterative procedure solves the matrix problem which relates frequency changes to changes in ionospheric parameters, showing the geographic distribution of ionospheric perturbations. Author (TAB)

N67-37100# Illinois Univ., Urbana. Electrical Engineering Research Lab.

IONOSPHERIC RESEARCH Quarterly Progress Report, 1 Jan.–31 Mar. 1967

H. D. Webb Apr. 1967 31 p refs

(Contract DA-36-039-AMC-03703(E))

(Rept.-14; QPR-14; AD-654420)

Moon-reflected signals were received for 234 hours on 32 days at 150.6 MHz and for 61 hours on 31 days at 413.25 MHz. There were several important solar flares and two significant magnetic storms. The data have not been studied for correlation of electron content irregularities with these events. Uncertainties are present in 1966 data from August through December Integrated electron content to the F2 maximum from ionograms and the topside to bottomside ratio are being used to resolve these uncertainties. Topside to bottomside ratios for October 1965 are being calculated using both Ft. Monmouth and local ionograms. Seasonal averages for 1965 data from February 24 through November 3 are presented which are adjusted to a common solar flux at 2800 MHz for each season. These are little different from the unadjusted seasonal averages because the variation in solar activity for 1965 was low. An AFC unit for the 413.25 MHz receiver and a SCR elevation motor control are being constructed. Signals from the ATS-B stationary satellite over the Pacific have been received. Author (TAB)

N67-37109# Sandia Corp., Albuquerque, N. Mex.

ANALYSIS OF PRESSURE MEASUREMENTS TAKEN AT ALTITUDES BETWEEN 30 AND 90 KM BY CONE-CYLINDER PITOT-STATIC PROBES

D. J. Rigali and K. J. Touryan Jun. 1967 37 p refs

(Contract AT(29-1)-789)

(SC-RR-251) CFSTI: HC $3.00/MF $0.65

Data from four Nike–Apache sounding rocket flights of cone-cylinder pressures probes are analyzed. The carrier rockets and the instrumentation are discussed in detail. Special emphasis is placed on error analyses, and the results are compared with two sets of data from falling sphere tests. Future plans are reviewed. Author (NSA)

N67-37195# National Committee for Space Research, Haifa (Israel). Radio Observatory.

IONOSPHERIC RESEARCH USING SATELLITES Annual Scientific Report

Jonathan Mass and Zwi Houminer 28 Feb. 1967 35 p refs

(Contract AF 61(052)-837)

(ASR-2; AFCRL-67-0355; AD-655392)

The ionospheric electron content above Haifa was determined for the period November 1964 - June 1966. The results reveal the expected diurnal variation, with midday maximum occurring between 13-14 hours local time. The ratio of the day-time maximum to night-time values of electron content is between 8-10 and is similar for all seasons. There is a marked seasonal and solar activity dependence. Maximum electron content values occur at the equinoxes and minimum at winter. The variation of the electron content with the mean Zurich sunspot number R is given approximately by the relation N sub t is proportional to 1 + 0.029 R. On several revolutions of the S-66 satellite, a strong change in the Faraday fading rate of the 40 and 41 Mc/s signals was observed for geometrically similar conditions. This change in Faraday rate is thought to be related to large scale, magnetic field aligned irregularities featuring local reduction in electron density. The irregularities were found to be located at about 17 degrees N latitude having thickness of about 60 km and average height close to F2 maximum. The reduction in the total content in the irregularity is of the order of 8%. Author (TAB)

N67-37207# Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology.

RESEARCH ON THE DYNAMICS OF AIR–SEA INTERACTION Progress Report

Erik Mollo-Christensen 10 Jun. 1967 36 p

(Contracts Nonr-1841(74); N140(122)27626B; Grant NSF GP-4321)

(AD-655471)

The purpose of the research is to find out more about the dynamics of the small scale processes in air sea interaction. TAB

N67-37266*# Southwest Center for Advanced Studies, Dallas, Texas.

INFLUENCE OF PARTICLE SIZE DISTRIBUTION ON REFLECTED AND TRANSMITTED LIGHT FROM CLOUDS Scientific Interim Report

George W. Kattawar and Gilbert N. Plass 24 Aug. 1967 43 p refs

(Grants NGR-44-004-026; NsG-269; Contract AF 19(628)-5039; Proj. 4076)

(NASA-CR-88489; SR-5) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The light reflected and transmitted from clouds with various drop size distributions is calculated by a Monte Carlo technique. Six different models are used for the drop size distribution: isotropic, Rayleigh, haze continental, haze maritime, cumulus, and nimbostratus. The scattering function for each model is calculated from the Mie theory. In general the reflected and transmitted radiances for the isotropic and Rayleigh models tend to be similar as are those for the various haze and cloud models. The reflected radiance is less for the haze and cloud models than for the isotropic and Rayleigh models, except for an angle of incidence near the horizon when it is larger around the incident beam direction. The transmitted radiance is always much larger for the haze and cloud models near the incident direction; at distant angles it is less for small and moderate optical thicknesses and greater for large optical thicknesses (all comparisons to isotropic and Rayleigh models). The downward flux, cloud albedo, and mean optical path are discussed. The angular spread of the beam as a function of optical thickness is shown for the nimbostratus model. Author

N67-37317# Woods Hole Oceanographic Institution, Mass.

THE NORMALLY-INCIDENT REFLECTIVITY OF THE SEA FLOOR AT 12 KC AND ITS CORRELATION WITH PHYSICAL AND GEOLOGICAL PROPERTIES OF NATURALLY-OCCURRING SEDIMENT

Lloyd R. Breslau Apr. 1967 146 p refs

(Contracts Nonr-4029(00); Nonr-1841(74); NObrs-72521; NObrs-89464)

(Rept.-67-16; AD-655245)

The objective of this investigation was to measure bottom loss in normal incident reflection of pulses of 12 kcps sound and to study its geological significance. A semi-automatic instrument system was developed capable of making continuous measurements of the peak pressure and the time integral of the square of the pressure of the sea-floor echo from a vessel underway. Observations were taken in both deep and shallow water in the Western North Atlantic. The early cruises were conducted in deep water to investigate the range and variability of bottom loss. Geological control consisted mainly of a precise bathymetric record. Later cruises were conducted in shallow water where the geology had been well studied previously. In these latter cruises the acoustic measurements were correlated with sediment dredging and underwater photography. Thirty-one thousand acoustic measurements were made. Median bottom loss values and standard deviations were computed and the results summarized in eleven hundred sets, each set corresponding with a location at sea. Seventy-seven sediment stations were occupied. A complete particle size analysis and a water content analysis were performed on these sediments to determine their size and mass characteristics. Author (TAB)

N67-37386# Utah Univ., Salt Lake City. Upper Air Research Lab.

ROCKET INSTRUMENTATION FOR SOLAR ECLIPSE MEASUREMENTS—12 NOVEMBER 1966

Karl G. Seljaas and David A. Burt Apr. 1967 88 p refs

(Contract AF 19(628)-5044)

(UU-67-2; SR-2; AFCRL-67-0336; AD-656342)

The report details instrumentation designed to measure the parameters in the D-region of the ionosphere during a total solar eclipse. Four Nike-Hydac rockets were fired from Cassino, Brazil, in connection with the eclipse of 12 November 1966; a test flight round was flown on 5 November, and the remaining three rockets were fired during various phases of the eclipse on 12 November. The rocket payloads were identical and were designed to measure the following parameters: Positive ion composition, Positive ion density, Positive ion energy distribution, X-ray flux, Lyman-alpha radiation, Electron density, Electron temperature. Author (TAB)

N67-37387*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

SATELLITE STUDIES OF THE LOWER ATMOSPHERE

W. Nordberg Jul. 1967 53 p refs

(NASA-TM-X-55942; X-620-67-332) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Meteorological satellite observations are discussed in relation to synoptic measurements of the upper and lower boundaries of the troposphere, and of the interaction between the atmosphere and the water or land surfaces of the earth. The physical characteristics of lower atmosphere radiation are considered in terms of satellite sensors, data interpretation, and analytical models. An assessment is made of sensors for mapping radiation patterns, and radiation sensors for atmospheric sounding. Technological requirements for meteorological satellites are specified according to stabilization and spacecraft attitude, orbits, and data analysis and transmission. Analytical data are included on the observed cloud patterns, hurricane development, earth-atmosphere radiative energy balance measurements, radiation observations of the earth-atmosphere interface, and atmospheric temperature and moisture. M.G.J.

N67-37398* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE GEOMAGNETIC SECULAR VARIATION, 1900–1965

Joseph C. Cain and Shirley J. Hendricks Sep. 1967 231 p refs

(NASA-TM-X-55944; X-612-67-479) CSCL 08N

The main geomagnetic field model uses linear and parabolic terms in time to represent secular change over the interval 1900–1965. The predicted field is compared with observatory annual means to investigate systematic residuals. Deviations of the order of 100γ are noted for short spans of years and are observed to occur only in limited regions. Otherwise, the trends of the computed field parallel the observations. Comparisons of secular change charts with those drawn by earlier analyses show good agreement. The westward drift is generally noted in the vector representation of the harmonic coefficients except that a few terms are seen to undergo predominantly an amplitude change. The components below (g^6, h^6) that show a recognizable eastward drift are the (3,2) and (5,2) terms. Both dip poles are noted to move smoothly northwestward over the interval whereas the dipole position initially drifts eastward, reverses direction near 1920, and then moves westward at a rate up to about 0.7°/year. Its 1965 position is found to be 78.8°N and 70.0°W. Author

N67-37411# Florida State Univ., Tallahassee. Dept. of Meteorology.

THE DYNAMICS OF THE STRATOSPHERE DURING THE 1958 WARMING

W. Alan Bowman 1 Jul. 1967 138 p refs

(Contract AF 19(628)-4953)

(Rept.-67-2; AFCRL-67-0366; SR-2; AD-655780)

Within the period from January 18 to February 10, 1958, a stratospheric warming occurred in the Northern Hemisphere. Maps of height and temperature for 100, 50 and 25 mb illustrate the onset of the warming in the region of the warm belt and the subsequent migration of the warm center across western Europe, Iceland and Canada. Vertical motion at 100, 50 and 25 mb was computed by the adiabatic method. Horizontal divergence at 100, 75 and 50 mb was computed. Vorticity and the vorticity budget at 100, 50 and 25 mb were evaluated. A numerical experiment was performed in which 25-mb temperatures were computed using data primarily at 100 and 50 mb. The computed values were found to be better than those obtained by a straightforward extrapolation scheme, particularly near the height of the warming. TAB

N67-37419# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.

ON THE PROBLEM OF INTERPOLATING DERIVATIVES OF THE GRAVITY POTENTIAL IN A MOUNTAINOUS REGION [K VOPROSU OB INTERPOLYATSII PROIZVODNYKH GRAVITATSIONNOGO POTENSIALA V GORNOY OBLASTI]

V. I. Aronov and V. M. Gordin Jun. 1967 12 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Geod. i Aerofotos. (Moscow), Issue 3, 1966 p 88–93

(ACIC-TC-1203; TT-67-62135; AD-653958) CFSTI: HC $3.00/MF $0.65

These articles deal with problems connected with the precision increase of the interpolation of delta g values in a mountainous region, together with the precision of the computation of derivatives of the gravitational potential (from the point of view of evaluating the magnitude of their interpolation errors) during calculations by the methods described. Author (TAB)

N67-37442# Geophysics Corp. of America, Bedford, Mass. GCA Technology Div.

EXTENSION TABLES FOR THE U.S. STANDARD ATMOSPHERE, 1962, WITH SPECIAL ATTENTION TO THE CALCULATION OF GEOPOTENTIAL

R. A. Minzner Jan. 1967 42 p refs

(Contract AF 19(628)-6085)

(GCA-TR-67-1-A; AFCRL-67-0335; SR-3; AD-655779)

The need for both metric-unit and English-unit tables as a function of integral multiples of specific numbers of geopotential meters for altitudes above 90 kilometers has prompted a new set of calculations, which required the use of equations not specifically presented in the United States Standard Atmosphere, 1962. The development of these equations is discussed and the value of all constants employed are given. The calculations involve a transformation between geopotential and geometric altitude, and the development of an empirical analytical expression relating these quantities is presented. This empirical function yields results which differ by less than 0.1 meter at 700 km altitude, from those computed in an unspecified manner for the United States Standard Atmosphere, 1962. TAB

N67-37485*# Texas Univ., Austin. Antennas and Propagation Div.

A RADAR DESIGN FOR ATMOSPHERIC TURBULENCE STUDIES

Allan B. Plunckett 1 Aug. 1967 71 p refs

(Contract NGR-44-012-048)

(NASA-CR-88494; P-20) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Atmospheric turbulence can presently be measured only on the ground or by means of airplanes flying through the turbulent area. A properly designed radar system may be able to detect and analyze atmospheric turbulence from a position remote from the turbulent area. The choices of antenna, wavelength, transmitter power, receiver sensitivity, and detection methods are examined. The differences between pulse or cw and bistatic or monostatic systems are discussed. A comparison with existing radar systems used for atmospheric turbulence research is made. Author

N67-37570 Atomic Energy Centre, Lahore (Pakistan). Chemistry Div.

LABELLING SAND WITH RADIOISOTOPES Progress Report

M. A. Lodhi and Shaukat Ali Feb. 1967 9 p refs

(Contract RB/143)

(PAEC/Miscell-1/Chem)

Radioactive tracers have proved very useful in the study of sand transport in hydraulic channels. Two methods are described for labelling the sand with radionuclides. One of the methods is to deposite a thin layer of metallic radionuclides like gold^{198} and silver^{110} on the surface of the sand by using formaldehyde as a reducing agent. The method is comparatively quick. The other method which is of a wider utility, consists of giving a surface coating of the desired radionuclide by mixing it with albumen solution. The methods described require no pretreatment of sand except simple washing. Author

N67-37581# Woods Hole Oceanographic Institution, Mass.

QUASI-SYNOPTIC MONTHLY HYDROGRAPHY OF THE TRANSITION REGION BETWEEN COASTAL AND SLOPE WATER SOUTH OF CAPE COD, MASSACHUSETTS

G. M. Cresswell Jul. 1967 100 p refs

(Contract N00014-66-C-0241)

(AD-655639)

Detailed hydrographic conditions are enlarged upon in the area south of Nantucket and Marthas Vineyard at the boundary between Coastal and Slope Water at the edge of the continental shelf off Cape Cod, Mass. Five monthly cruises were made during a spring-summer season from May to September, 1958 to study detailed temperature and salinity distribution in both water masses at their boundary. Basic midsummer volumetric relations are given between water on the shelf and that in a parcel moved offshore, an inferred rate of formation of such parcels for July, the seasonal reduction in volume of cold shelf bottom water, and the monthly variation of areas between given isohalines in the halocline. Maximal observed salinity gradient is 2.4 0/00 per 10 meters. Parcel detachment is initiated by turbulence from internal waves shoaling in the density gradient of the halocline when the residual winter cooled shelf bottom water is in a state of quasi-inequilibrium. Tidal agitation then provides energy to move the parcel offshore. Instability and many inversions are observed in the collected data. Mixing between Coastal and Slope Water occurs on the larger scale of parcels of the former moving offshore into the latter and also by small scale exchange across the transition region separating the water masses. Regional development on the shelf edge thermal structure which effects offshore movement of the parcels is seasonal and is due to given occurrences in the shelf-slope area. Development both of them and an offshore body of water of temperature structure similar to it was extreme in 1958. TAB

N67-37693# Travelers Research Center, Inc., Hartford, Conn.

PARTICLE FALL AND DISPERSION IN THE ATMOSPHERE Semifinal Report, Sep. 9, 1966–Jan. 31, 1967

K. D. Hage Feb. 1967 40 p refs Sponsored by AEC Prepared for Sandia Corp., Albuquerque, N. Mex.

(SC-CR-67-2534) CFSTI: HC $3.00/MF $0.65

Program modifications, tests, and computational aids are described for a particle transport and dispersion model that was developed previously as a tool in investigations of possible hazards associated with aborted missions or orbital-decay reentries of space vehicles using nuclear fuels. The major program modifications are: an increase in the scope of the simulated wind fields in the model, and an improvement in the method of computing deposit densities. The minimum particle size that can be used in the model is found to be about 3 microns. Suggestions are given for the specification of time-step interval, subdivision criteria, simulated wind field, and program option selections. Author (NSA)

N67-37697# Control Equipment Corp., Needham Heights, Mass.

INSTRUMENTATION AND TECHNIQUES FOR UPPER ATMOSPHERE MEASUREMENTS Final Report, 15 May 1965–14 May 1967

Harry E. Adams 1 Jun. 1967 12 p

(Contract AF 19(628)-5147)

(AFCRL-67-0371; AD-656393)

Instruments and techniques for the measurement of the density, pressure, and temperature of the earths upper atmosphere and for the determination of the reaction kinetics of atmospheric gases have been developed jointly by contractor and AFCRL. Engineering drawings, techniques, and experimental results have been documented directly by AFCRL. Author (TAB)

N67-37641# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.

SIGNIFICANCE OF EPEIROGENETIC CURVES FOR THE INTERPRETATION OF SPATIAL DISTRIBUTION OF THE GEOMAGNETIC FIELD [ZNACHENIE EPEYROGENICHESKIKH KRIVYKH DLYA INTERPRETATSII PROSTRANSTVENNOGO RASPREDELENIYA GEOMAGNITNOGO POLYA]

V. V. Kruglyakov and G. I. Kruglyakova Jun. 1967 17 p Transl. into ENGLISH from Sov. Geol. (USSR), no. 11, 1966 p 68–77
(ACIC-TC-1194; TT-67-62396; AD-655703)

Until now the maps of isolines for the magnetic field on the observation area were compiled according to data of the terrestrial and aeromagnetic surveys. These maps were used in the geological interpretation. The method of spacial distribution of the geomagnetic field was sometimes used in the quantitative interpretation of separate anomalies. A wider application of the spacial analysis was hampered by the bulk of computations. Introduction of electronic computers made it possible to more fully utilize the magnetometric data and to pass over from the observation analysis on the plane to the analysis of spacial distribution of the genomagnetic field. TAB

N67-37660# Massachusetts Inst. of Tech., Cambridge. Dept. of Geology and Geophysics.
POTENTIAL APPLICATIONS OF MAGNETIC GRADIENTS TO MARINE GEOPHYSICS
William E. Byrd, Jr. (M.S. Thesis) Jun. 1967 134 p refs
(Contract Nonr-1841(74))
(AD-655892)

Chapter I is a consideration of the application of magnetic gradients to marine geophysics and it shows that gradients are well-suited to the investigation of sea floor structure. Gradients may be utilized in the following areas of study: investigation of magnetic anomaly fine structure; delineation of geologic contact position and orientation; estimation of depth to source and source type; and determination of magnetization direction from topographic effects. This chapter also discusses the requirements for a marine magnetic gradiometer and proposes a system utilizing two Zeeman effect sensors in a stable vertical towed array. It also includes investigation of error sources and means for their correction or reduction. Chapter II reviews present knowledge and theory of ocean ridge structure, with emphasis on the characteristic magnetic anomalies observed over the ridges. We propose that these anomalies arise from a sub-horizontal layered structure composed of basaltic flows which have originated in the ridges axial region. Included in this presentation is a sub-horizontal layered model of the Reykjanes Ridge. Computed magnetic anomaly profiles over this model correlate well with observed profiles taken from a survey by Heirtzler. TAB

N67-37669# Kiruna Geophysical Observatory (Sweden).
AURORAL ZONE IONOSPHERIC RESEARCH Final Scientific Report, 1 Mar. 1963–31 Mar. 1967
Ludwik Liszka 23 May 1967 18 p refs
(Contract AF 61(052)-678)
(AFCRL-67-0416; AD-655393)

During years 1963-66 transmissions from satellites: Transit 4A and S-66 were recorded at Kiruna (66 degrees N, 20 degrees E), Sweden and used for studies of ionospheric irregularities and ionospheric electron content. Most important results of the studies obtained during the report period are presented. Author (TAB)

N67-37679*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
OBSERVATIONS OF SEA SURFACE TEMPERATURES AND OCEAN CURRENTS FROM NIMBUS II
Guenter Warnecke, Lewis J. Allison, and Lonnie L. Foshee Aug. 1967 14 p ref Presented at the COSPAR 19th Plenary Meeting, London, 24–29 Jul. 1967
(X-622-67-435) CFSTI: HC $3.00/MF $0.65 CSCL 08C

Radiometric high resolution infrared measurements recorded by the Nimbus II meteorological satellite in the 2.4–4.2 atmospheric window region yielded a complete and detailed global mapping of equivalent blackbody temperatures for a 6 month period. Under clear sky conditions, surface temperatures can be determined within an accuracy of ±1 to 2°K if corrections of 1 to 5°K are applied for residual absorption by atmospheric water vapor and carbon dioxide, depending on the atmospheric composition and scan nadir angle. A good agreement exists between the satellite measurements and sea surface temperature measurements from aircraft and ships. Of particular interest in this investigation was the usefulness of these infrared measurements for the detection of sea surface temperature discontinuities. Author

N67-37698 Library of Congress, Washington, D. C. Aerospace Technology Div.
ELECTROMAGNETIC WAVE PROPAGATION AND THE UPPER ATMOSPHERE Surveys of Foreign Scientific and Technical Literature
21 Sep. 1967 52 p refs /ts Work Assignment No. 3
(ATD-67-36; Rept.-4)

Twenty-nine abstracts are presented of Soviet open-source literature dealing with electromagnetic wave propagation and the upper atmosphere. These abstracts are arranged alphabetically by author under the categories of (1) ionosphere, exosphere, and magnetosphere; (2) geomagnetic micropulsations and earth currents; (3) ionospheric perturbations by explosions, satellite and missile passage, and solar radiation; (4) satellite and missile experiments; (5) radio and radar astronomy; and (6) aurora and geomagnetic disturbances. All of the articles are available at the Aerospace Technology Division of the Library of Congress, and source code numbers are included for each of the entries. A complete author index is appended. M.W.R.

N67-37792# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
GEOLOGICAL DATA ON THE AEROMAGNETIC SURVEY OF THE SOUTHEASTERN PART OF THE RUSSIAN PLATFORM AND ITS FOLDED FRAMING [GEOLOGICHESKIYE RESUL'TATY AEROMAGNITNOY S'YEMKIYUGO-VOSTOCHNOY CHASTI RUSSKOY PLATFORMY I YEYE SKLADCHATOGO OBRAMLENIYA]
D. P. Kasatkin Jul. 1967 17 p refs Transl. into ENGLISH from Sov. Geol. USSR (Moscow), no. 10, Oct. 1966 p 69–78
(ACIC-TC-1237; TT-67-62342; AD-655700)

The southeastern part of the Ukrainian uplift and the Caspian region basin together with the adjacent parts of the Volga-Ural uplifts, the Voronezh uplift and the system of depressions of the Cisural basin are the main structural-tectonic elements of the southeastern part of the Russian platform. The folded framing is composed of the Ciscaucasus--Kopet-Dag Epihercynian platform of the western part of Tien Shan, the Southern Ural and the southern part of the Turgay depression. The magnetic field, characteristic of this territory, is probably connected with sources situated in the crystalline base (Kasatkin, 1965). We assume that within the limits of the Russian platform and the northern Ciscaucasus-Great Donbas the base belongs to the Precambrian age. In the northern part of the territory of Southern Ciscaucasus-Stavropol region and the Ciscaucasian foredeep the base also belongs to the same age, while in the remaining part it belongs to the Paleozoic age, apparently to the Pre-Upper Devonian period. In the Transcaspian region, which includes parts of the Southern Ural and Tien Shan, the base belongs to the Pre-Upper Devonian period, while on the Southern Ural (partially) and in the Western Tien Shan it belongs to the Post-Middle Devonian (Hercynian) period. The sources of the magnetic anomalies are mainly bedded in the roof of the crystalline base, however some are situated within it, mostly in the depressions of the roof. TAB

N67-37793# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.

AN EXPERIMENT WITH THE CONSTRUCTION OF A GEOMAGNETIC MAP FROM DATA OF AN ARTIFICIAL EARTH SATELLITE [OPYT POSTROYENIYA GEOMAGNITNOY KARTY PO DANNYMISZ]

N. V. Adam, N. P. Ben'kova, and L. O. Tyurmina Jul. 1967 11 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), vol. 4, issue 3, May–Jun. 1966 p 463–468
(ACIC-TC-1240; TT-67-62384; AD-655702)

Presented is a map of the total intensity of the magnetic field above the territory of the USSR, constructed from measurements taken by the third artificial earth satellite. For the reduction to a single altitude (400 km is the altitude at which most measurements were taken) gradients were used, which were computed on the basis of a spherical harmonic analysis of the universal magnetic map of 1955, compiled by IZMIR AN USSR. The precision of the obtained map was evaluated (350 gamma) and the conclusion drawn that it presents a reliable picture of the geomagnetic field above the territory of the USSR. TAB

N67-37829# RCA Victor Co., Ltd., Montreal (Quebec). Research Labs.

SCALING OF GEOPHYSICAL PHENOMENA FOR LABORATORY SIMULATION EXPERIMENTS

M. P. Bachynski *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 403–426 refs (See N67-37816 22-25)

It is impossible to scale simultaneously all of the phenomena and interactions which occur in the geophysical environment of the earth. However, it is possible to isolate a specific type of interaction, scaling conditions so as to study it in a controlled manner over a range of parameters. This implies that each phenomenon requires a different set of scaling laws and, in general, a different laboratory simulation experiment. In this paper, the above philosophy of scaling of geophysical phenomena for laboratory simulation experiments is developed and scaling laws and their limitations discussed for a number of specific interactions, including the interaction between the solar wind and the magnetosphere and perturbations induced in the ionospheric plasma by satellites. Author (ESRO)

N67-37848# Instituto y Observatorio Astronomico de Marina, San Fernando (Spain).

AERONAUTICAL ALMANAC, SEPTEMBER–DECEMBER 1967 [ALMANAQUE AERONAUTICO, SEPTIEMBRE–DICIEMBRE, 1967]

1967 75 p In SPANISH

The Marine Observatory, in San Fernando, Spain, presents a manual of aeronautical data which should be helpful to pilots. The period covered is September 1, 1967 through January 1, 1968, and time is shown as Greenwich time. The Sun, the Moon, and the planets are included in the tables. R.U.

N67-37872# Aeronautical Chart and Information Center, St. Louis, Mo. Chart Research Div.

ON RELATION OF MAGNETIC ANOMALIES TO THE STRUCTURE OF THE EARTH CRUST IN THE SOUTHEASTERN PART OF CENTRAL KAZAKHSTAN

L. I. Puchkova and A. V. Ladynin Jun. 1967 15 p refs Transl. into ENGLISH from Geol. i Geofiz., Akad. Nauk SSSR, Sibirsk. Otd. (Novosibirsk), no. 12, 1965 p 126–134
(ACIC-TC-1193; TT-67-62344; AD-655698)

Lately there are attempts to utilize the data of the aeromagnetic survey in the study of both the abyssal structure of the earths crust and the structure of its upper stratified horizons. In order to explain the relations between magnetic anomalies of different orders and the structure of various horizons of the earths crust we utilized the material of the aeromagnetic survey, geological data and the diagrams of the earths crust constructed on the basis of geological and gravimetrical data for the southeastern part of Central Kazakhstan. Good exposure of the region makes it possible to quite reliably determine a correlation between magnetic anomalies and various geological bodies. TAB

N67-37874# Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology.

PLANETARY TRANSPORT PROCESSES IN THE UPPER ATMOSPHERE Annual Progress Report, 15 May 1967

Reginald E. Newell 15 May 1967 19 p refs
(Contract AT(30-1)-2241)
(MIT-2241-31) CFSTI: HC $3.00/MF $0.65

Progress is reported on the studies of the physical cause of the biennial oscillation in zonal wind and temperature in the tropical stratosphere. A complete list of publications and reports is also included. Observational data and theories pertinent to problems of the circulation of the stratosphere, mesosphere, and thermosphere have been studied. These include: biennial oscillation in zonal wind and temperature in the tropical stratosphere; year to year modulation in eddy fluxes in the stratosphere; spring maximum in ozone amount (and in concentration of radioactivity in ground level air) due to the enhancement of the vertical flux into the stratosphere from the troposphere; interaction of the upper and lower layers of the atmosphere; vertical propagation of quasi-geostrophic planetary waves; atmospheric tides; and the transfer of heat and momentum in the thermosphere by large scale motions. NSA

N67-37900*# Committee on Extension to the Standard Atmosphere (COESA).

U.S. STANDARD ATMOSPHERE SUPPLEMENTS, 1966

[1966] 304 p Sponsored by ESSA, NASA, and AF
(NASA-CR-88870) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Presented are atmospheric tables depicting conditions other than the mid-latitude mean represented by the tables of the *U.S. Standard Atmosphere, 1962*. Tables of typical winter and summer conditions for various latitudes are provided for the troposphere, stratosphere, and mesosphere. The models merge into three sets of boundary conditions at 120 km in the lower thermosphere, then branch upward into atmospheric profiles which are related to the wide range of conditions in the heterosphere associated with varying solar activity, geomagnetic activity, and zenith angle of the sun. Two major sets of tables are provided: those for the region below 120 km, keyed to seasonal and latitudinal variations; and those for 120 to 1000 km, keyed to solar and geomagnetic activity and solar angle. In addition, this publication contains information on diurnal variations in density up to 90 km, refined analytic expressions which can be used to represent pressure and density profiles of the 1962 Standard and these Supplementary Atmospheres to 80 km, and a mid-latitude ozone model up to 50 km. Tables providing the altitude variation of equal geopotential surfaces as a function of latitude are given. A set of detailed pressure–altitude tables for levels from the surface up to 10 millibars is included. Author

N67-37925*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.

ELECTRIC CURRENTS INDUCED BY NON-PERIODIC WINDS IN THE IONOSPHERE

Hiroshi Maeda and Hiroo Murata (Kyoto Univ., Japan) [1967] 42 p refs
(NASA-TM-X-60375) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Electric currents induced by non-periodic winds in the ionosphere are calculated for the case of incoincidence of the Earth's rotational and magnetic axes, based on a realistic model of the upper atmosphere. Main results obtained are (1) Sq-like current systems changing with universal time are produced and the intensity of main vortices is about one-tenth of that of the Sq field for a typical wind velocity of 10 m/sec. (2) Of the two components of non-periodic winds, the meridional component is more effective in producing current systems. (3) The position of main current vortices is controlled by the distributions of ionospheric conductivity and wind velocity. (4) The intensity of main vortices changes with longitude in such a manner that the maximum intensity occurs in the North and South American zone and the minimum in the Asia and Oceania zone. Author

N67-37990*# Scientific Translation Service, La Canada, Calif.
DUST CONTENT IN THE UPPER ATMOSPHERE OF THE EARTH [O SODERZHANII PYLI V VERKHNEY ATMOSFERE ZEMLI]
N. B. Divari Washington, NASA, Oct. 1967 5 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 5, May–Jun. 1967 p 475–477
(Contract NASw-1496)
(NASA-TT-F-11316) CSCL 04A

A critical analysis is presented of a result obtained from measurements of the attenuation of starlight, according to which there should be no dust whatsoever at heights on the order of 100 km. It is shown that this result contradicts modern estimates of the dust content in the upper atmosphere obtained from light absorption measurements from satellites. Author

N67-38031*# Geophysics Corp. of America, Beford, Mass. GCA Technology Div.
SODIUM VAPOR EXPERIMENT Quarterly Progress Report, 1 Apr.–Jun. 1967
Aug. 1967 25 p
(Contract NAS5-3970)
(NASA-CR-88882; QPR-8) CSCL 04A

The general objectives of sequential vapor trails to investigate vertical wind structure variations are discussed, and the inconclusive data obtained from two series conducted at Wallops Island are assessed. Plans to repeat the test are outlined. A wind profile is depicted on the vapor trail ejected from a Nike Apache rocket fired at Fort Churchill, Canada, and general methods of data analysis are described. Questions pertaining to the accuracy and application of the vapor trail method are examined in relation to observations of vertical winds and turbulent structure. An analytical description is included on wind measurements by the photographic method. M.G.J.

N67-38050# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CENTRAL AEROLOGICAL OBSERVATORY
11 May 1967 52 p refs Transl. into ENGLISH from Tsentr. Aerol. Observ. (Moscow), no. 53, 1964 p 21–34
(FTD-MT-65-304; TT-67-62279; AD-655020)

CONTENTS:

1. CERTAIN RESULTS OF INVESTIGATIONS OF THE MESO AND MICROSTRUCTURE OF THE WIND FIELD AT HEIGHTS OI 6–12 km N. Z. Pinus p 1–26 refs (See N67-38051 22-13)

2. TURBULENCE WHICH INDUCES AIRCRAFT BUFFETING IN THE ZONE OF CUMULONIMBUS CLOUDS A. A. Reshchikova, V. I. Silayeva, and S. M. Shmeter p 27–45 refs (See N67-38052 22-13)

N67-38051# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CERTAIN RESULTS OF INVESTIGATIONS OF THE MESO- AND MICROSTRUCTURE OF THE WIND FIELD AT HEIGHTS OF 6–12 KM [NEKOTRYYE REZUL'TATY ISSLEDOVANIY MEZO- I MIKROSTRUKTURY POLYA VETRA NA NYSOTAKH 6–12 KM]
N. Z. Pinus *In its* Central Aerological Obs. 11 May 1967 p 1–26 refs (See N67-38050 22-13)

Presented are data on the accuracy of measurements of wind speed and direction which were made on a TU-104 aircraft equipped with a navigational Doppler system; results of studies of wind speed horizontal component fluctuations; and empirical structural functions for heights of 6 to 12 km. Author

N67-38052# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TURBULENCE WHICH INDUCES AIRCRAFT BUFFETING IN THE ZONE OF CUMULONIMBUS CLOUDS [TURBULENTNOST' VYZYVAYUSHCHAYA BOLTANKU SAMOLETOV V ZONE KUCHEVODOZHDENVYKH OBLAKOV]
A. A. Reshchikova, V. I. Silayeva, and S. M. Shmeter *In its* Central Aerological Obs. 11 May 1967 p 27–45 refs (See N67-38050 22-13)

On the basis of data from special test flights in atmospheric turbulence, causing aircraft buffeting in the Cumulonimbus (Cb) cloud zone, studies were made of the frequency and intensity of buffeting of jet aircraft near the tops of Cb clouds and partially within them. Examined is the influence of wind flow effects around Cb clouds on the structure of aircraft-turbulence zones near these clouds. Author

N67-38059# Tracerlab, Inc., Richmond, Calif.
SNAP-9A PARTICLE STUDIES Quarterly Report, 15 Jul.–15 Oct. 1966
Walter D. Hollander 28 Dec. 1966 36 p refs
(Contract AT(30-1)-3547)
(TLW-3547-4; TLW-1104c; QR-4) CFSTI: HC $3.00/MF $0.65

Portions of high altitude filter samples known to contain ^{238}Pu from the SNAP-9A satellite failure were investigated to determine the size and composition of these ablation particles. A radioautographic determination of ^{238}Pu content was made to estimate the particle sizes. The samples were divided into 4 cm^2 pieces, ashed at low temperature on microscope slides, and covered with liquid nuclear emulsion. Optical microscopic examination disclosed that alpha stars containing as many as 1,000 tracks were present on the slides which contained SNAP-9A debris. However, no stars of more than five tracks were found on either the slides of flown background or blank filters. Assuming an alpha track-disintegration conversion factor of two for all stars with SNAP-9A significance (those with more than five tracks), sufficient equivalent $^{238}PuO_2$ particle diameters were predicted from eight samples to enable the plotting of their size distributions. The distributions are log normal with a peak at 12 to 14 mμ with the particle diameter ranging from 10 to 46 mμ. Latent image fading and obscuring of alpha stars by extraneous particles on the slides have been investigated and found not to affect these results appreciably. Recent studies using similar sample, background, and blank slides exposed for one year indicate the presence of numerous SNAP-9A particles with diameters from 5 to 10 mμ which were not detected in one month exposures. The 12 mμ peak was noted in the results from the one year samples, but no mode was

observable between 5 to 10 mμ. Longer exposures are planned to determine the 3 to 5 mμ range of the curve. In an effort to obtain a means for viewing SNAP-9A particles in the electron microscope, the hollow star technique was developed and found a promising aid for this purpose. The hollow star technique utilizes an exposure arrangement for two microscope slides. By knowing the exposure time, number of tracks within a selected radius of the center and the spacer distances, it is possible to calculate an equivalent $^{238}PuO_2$ diameter. By making numerous exposures of several SNAP-9A particles and using different shim thicknesses, the technique has been evaluated and found to contain no large experimental errors. The results of exposures of impactor collections of SNAP-9A debris on nitrocellulose and silicone oil coated slides are also described. In both cases, the hollow star technique has been used to detect SNAP-9A debris. These samples are particularly useful because they do not have to be ashed before being examined for SNAP-9A particles. Provided suitable methods are developed, these particles will be viewed in the electron microscope. In addition, these studies may reveal bonus information regarding the agglomeration of these particles with nonradioactive particles in the atmosphere. Author (NSA)

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N67-36703*# Texas Univ., Austin. Defense Research Lab.
THE DESIGN AND CONSTRUCTION OF FLOATING-ELEMENT SKIN-FRICTION BALANCES FOR USE AT 50° TO 150°F
J. C. Westkaemper [1967] 44 p refs
(Contract NAS1-5572)
(NASA-CR-66423) CFSTI: HC $3.00/MF $0.65 CSCL 14B

This report presents the results of a study of the use of floating-element skin-friction balances for use over a moderate range of temperature and heating rates. The study included an investigation of the buoyancy forces on the floating element and of the use of pressure orifices in the balance case to indicate element misalignment. The case orifices were found to be too large to give an accurate indication of vertical misalignment; the size also precluded their use to determine the buoyancy forces. The orifice size necessary to accurately indicate buoyancy forces appears to be too small to be mechanically practicable. The main influence of temperature variations appears to be a combination of thermal expansion on thermal strains in the mechanical components of the balance design used. These effects were minimized by selective assembly so that the individual contributions of the components cancelled out in the complete balance. This method proved very tedious and time-consuming, particularly for balances with high sensitivities. Author

N67-36715# Autonetics, Anaheim, Calif.
FUNCTIONAL EVALUATION OF ELECTROLUMINESCENT PICTORIAL STATUS DISPLAYS Interim Report, 1 Mar. 1966–15 Jul. 1967
John S. Frost and Robert H. Wright 15 Jul. 1967 41 p
(Contract N00014-66-C-0135)
(C7-1794/301; AD-655690)

An electroluminescent display for pictorially presenting aircraft fuel and configuration status information was designed and fabricated, and performance with it was compared to performance with a conventional display panel containing comperable information. Slides of comparable configurations of the two display panels were presented to subjects for short (2 second) and long (10 second) exposures in a partially counterbalanced design. For the short exposure, subjects were required to report the fuel tank being monitored, its amount, the total fuel amount, and any additional status information which could be detected. It was found that additional qualitatively different information could be provided on the electroluminescent display in a smaller panel area, providing display redundancy and a pictorial relatedness to aircraft status that could not be obtained with conventional displays. The test results indicated the electroluminescent display to be generally superior to the conventional panel in terms of both errors and performance times. Times required to report the tank being monitored, the tank amount, and the total fuel amount, were all significantly less when using the electroluminescent display, and overall, fewer errors occurred although this result was not obtained on all items for which errors were obtained. The results are discussed with respect to characteristics of information encodement in the two types of displays. Author (TAB)

N67-36720*# Ohio State Univ. Research Foundation, Columbus. Dept. of Electrical Engineering.
THE USE OF AN OSCILLOSCOPE FOR THE MEASUREMENT OF SNR
Jon W. Eberle 15 Jan. 1964 13 p refs
(Grant NsG-213-61)
(NASA-CR-88405; Rept.-1388-11) CSCL 09F

A technique is described for obtaining the signal to noise ratio of a signal in the presence of noise. The only instrument required is an oscilloscope. The accuracy of the method is dependent upon the ability of the observer to determine the point of peak intensity of the displayed waveform. Author

N67-36739# National Bureau of Standards, Washington, D. C.
DISCLOSURES ON: A TRANSROTOR ENGINE, HIGH TEMPERATURE PLATINUM RESISTANCE THERMOMETER, DYNAMIC ANALOG CORRELATION SYSTEM, AND COMBINATION METERING AND SAFETY VALVE FOR FILLING SONDE BALLOONS WITH HYDROGEN
David Robbins, ed. and Alvin J. Englert, ed. 21 Oct. 1966 26 p
(NBS-TN-295) GPO: $0.25

Descriptions and drawings of four devices are presented embodying interesting and unusual solutions to problems frequently encountered in their respective fields: a transrotor engine, a dynamic analog correlation system, a high temperature platinum resistance thermometer, and a combination metering and safety valve for filling sonde balloons with hydrogen. Author

N67-36742* Carnegie Inst. of Tech., Pittsburgh, Pa. Biophysical Research Lab.
A RAPIDLY RECORDING MICROSPECTROPHOTOMETER Progress Report, Apr. 1–Sep. 30, 1967
Jerome J. Wolken, R. Forsberg, G. Gallik, and R. Florida 25 Sep. 1967 23 p refs
(Grant NGR-39-002-011)
(NASA-CR-88491) CSCL 20F

A Microspectrophotometer M-5 of increased sensitivity has been constructed to record absorption spectra rapidly in a single sweep from the ultraviolet through the visible, from 2500 to 8000 Å. The M-5 records from single cells and from cell organelles of the order of 0.5 μ^2, using minimum light. The general design, the nature of the component parts, and the performance of the instrument are reviewed. Author

N67-36761 Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Porz (West Germany). Institut fuer Raumsimulation.
THE PUMPING SPEED FOR CARBON DIOXIDE BY THE ACTION OF A SURFACE COOLED BY LIQUID NITROGEN AT GAS TEMPERATURES RANGING FROM 136°K TO 548°K [UNTERSUCHUNG DES SAUGVERMOEGENS EINER MIT FLUESSIGEM STICKSTOFF GEKUEHLTEN FLAECHE FUER KOHLENDIOXID BEI GASTEMPERATUREN VON 136° K BIS 548°K]
Georg Saenger Jul. 1967 28 p refs In GERMAN; ENGLISH summary
(DVL-660; DLR-FB-67-43)

Results are discussed of pressure measurements ranging from $6 \cdot 10^{-7}$ Torr to $8 \cdot 10^{-5}$ Torr, and a description is given of the measuring equipment that was used. The relation between pumping speed of the cryosurfaces and thermal conductivity of the condensed gas layer is theoretically considered. After establishing the constants it becomes possible to predict the pumping speed also for other temperatures of the cryosurface in a vacuum and the condensing gas within certain limits. Good agreement exists between theoretical findings, measured data, and results obtained by other authors. Transl. by K.W.

N67-36814# Western Ontario Univ., London. Dept. of Physics.
TRANSIENT RESPONSE IN RADIO REFRACTOMETERS Interim Scientific Report
Donald R. Hay, David A. Stewart, and J. Howard Aitkenhead Nov. 1966 61 p refs
(Contract AF 19(628)-3835)
(TP-3; AFCRL-67-0014; AD-655135)

Previous work showed that radio refractometers indicate air refractivity that is too high for relative humidity exceeding 60 percent, for air temperatures above freezing. This error is due to the growth of an adsorbed vapour layer on the sensor whose depth increases to 1.5 micron and refractivity to 1.025 near saturation, where condensation appears. A coating of beeswax reduces the adsorption error substantially. Three aspects of the investigation are continued here—modification of the H–F test refractometer for reliable functioning at subfreezing temperatures, development of a technique for measuring its effective thermal lag and temperature coefficient, and extension of the wind tunnel techniques for observations at sub-freezing temperatures. Details of the new test refractometer age given; its present thermal lag and temperature coefficient permit it to measure refractivity within 100,000 over height intervals between 1 and 250 cms during a normal balloon ascent. For ventilation rates of 400 and 800 feet per minute, the adsorption effect is the same except at humidities above 90 percent. The adsorption error appears to decrease with decreasing air temperature, above freezing. Preparations are underway for better control of air humidity in the tunnel below freezing point, for improvement in the temperature compensation of the refractometer, and for additional observations on the response of the refractometer to transients in humidity and temperature.
Author (TAB)

N67-36817* Texas Univ., Austin. Dept. of Astronomy.
MODIFICATION OF 82-INCH COUDE SPECTROGRAPH AT MC DONALD OBSERVATORY
Harlan J. Smith 31 Dec. 1966 17 p refs
(Contract NASr-230)
(NASA-CR-88383) CSCL 03A

Resolution of some problems connected with the correction of problems associated with the existing large coude spectrograph of the telescope were corrected during this reporting period. Certain auxiliary instruments were added to the system, and improved capability was demonstrated for planetary work in preparation for observations of Mars and other planets. There is included a summary of initial results achieved with the new spectrograph and accessories. R.U.

N67-36822* Chrysler Corp., New Orleans, La. Space Div.
PRESSURE GAGES, 4.5-INCH HELICOID GAGE DIVISION, AMERICAN CHAIN AND CABLE CO. PART NUMBERS 3956D, 3956M, AND 3956T
A. C. Billiodeau 15 Apr. 1967 94 p
(Contract NAS8-4016)
(NASA-CR-88555; TR-RE-CCSD-FO-1003-3) CSCL 14B

The pressure gages are to be used at Launch Complexes 34 and 37 of the John F. Kennedy Space Center in the following equipment: pneumatic control distributors, valve panels, deluge purge panels, and oxygen conditioning systems. The operating medium is either dry air, nitrogen, helium, or oxygen. The following tests were conducted: (1) receiving inspection; (2) proof pressure and functional; (3) low and high temperatures; (4) vibration and surge; (5) humidity, sand, dust, and salt fog; (6) life cycle; (7) final inspection; and (8) burst. K.W.

N67-36850 Royal Aircraft Establishment, Farnborough (England).
A DRIVE UNIT FOR THE TESTING OF TACHOMETER-GENERATORS
P. A. Stickels May 1967 13 p
(RAE-TR-67121)

A tachometer–generator drive unit is described which is capable of providing a range of discrete speeds from 500 rev/min to 6000 rev/min. Use is made of an existing Velodyne and its associated control circuit to which an additional phase sensitive error signal is fed. The long term accuracy approaches that of the crystal oscillator which is used as a reference source. The limits within which the instanteous velocity may vary have not been determined. Author

N67-36864* Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
CONTOURED SKIN FRICTION TRANSDUCERS
R. C. MacArthur Aug. 1967 30 p refs
(Contract NAS2-4053)
(NASA-CR-73123; CAL-AN-2403-Y-1) CSCL 14B

A new type skin friction transducer intended for use in shock tunnels is described. The design is improved over previous transducers developed. A small, rugged and reliable amplifier is included within the 1/4" diameter by 3/8" thick transducer case. The active, i.e., skin friction, diaphragm may be replaced with a diaphragm of another contour to accommodate a different model shape. Acceleration compensation, an essential feature, is incorporated. Power gains of over one million make this device practically free of the troublesome cable noise usually experienced with similar devices when used at low skin friction levels. Author

N67-36882 Aeronautical Research Council (Gt. Brit.)
A NOTE ON THE DESIGN AND CONSTRUCTION OF A LOW-PRESSURE CALIBRATOR AND A COMPARISON WITH SHOCK-TUBE AND STATIC CALIBRATION METHODS
R. J. Pallant 1967 17 p refs
(ARC-CP-947)

This Report describes the design and construction of a semidynamic calibrator for use with transducers at subatmospheric pressures. Pressure rise times of 500μs have been achieved with pressure steps of the order of 5mm Hg absolute. The results of calibration checks on three piezoelectric transducers are compared with shock tube and static calibrations. Author

N67-36899# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
GRAVITY MEASUREMENT INSTRUMENT [USTROYSTVO DLYS IZMERENIYA SILY TYAZHESTI]
V. P. Kheyfets Jun. 1967 9 p Transl. into ENGLISH from Byul. Izobretenii i Tovarnykh Znakov (Moscow), no. 15, 1967 p 89–90
(ACIC-TC-1191; TT-67-62154; AD-653960)

Seven instruments for measuring gravity are described in the article. Author (TAB)

N67-36901# HRB-Singer, Inc., State College, Pa.
PRELIMINARY AERIAL INFRARED FIRE MAPPING SYSTEMS ANALYSIS Final Report, Feb. 1966–Jul. 1967
Richard D. Sheeder and Gretchen L. Duguay Apr. 1967 82 p refs
(Contract N000228-66-C-0394)
(Rept.-9711-F; AD-655685)

A detailed analysis of factors relevant to the infrared thermal mapping of hypothetical nuclear bursts in the state of Michigan was performed. Areas deemed critical to the recovery of the state were determined and designated to be the areas mapped in the event they were struck by a nuclear burst. A survey of civilian aircraft was performed to determine the number and distribution of those possibly available to perform the mapping flight. The total time for the mapping missions was computed for four different thermal mapping system options, and for three different levels of mapping resources. An analysis of the numerical data was performed. Author (TAB)

N67-36994 Library of Congress, Washington, D. C. Aerospace Technology Div.
SOVIET DEVELOPMENT OF SCIENTIFIC RESEARCH INSTRUMENTS
Jordan V. Randjelovic 11 Oct. 1967 61 p refs
(ATD-67-39; Rept.-5)

Abstracts selected from open-source literature are presented, emphasizing radiation sensor development. Also covered are optical, gas, vibration, and plasma temperature sensors. A bibliography is appended. N.E.N.

N67-37008*# California Univ., Berkeley. Space Sciences Lab.
AN ALL-SKY CAMERA FOR CONTINUOUSLY MONITORING CLOUD COVERAGE
D. W. Wilson, R. Dorr, W. Daniel, M. I. Raff, J. A. Sexton et al 17 Aug. 1967 35 p *Its* Ser. No. 8, Issue No. 57
(Grants NsG-101-61; NsG-243-62)
(NASA-CR-88525) CSCL 14E

The spherical convex reflector, sequence recording camera, electronics package, and mounting frame for an all sky camera designed for recording the extent of the day and night cloud cover over an area in the White Mountains in eastern California (to evaluate the suitability of the site for a large planetary telescope) are described. The film used is very fast, with high contrast, low granularity, and wide exposure latitude. Color film was selected over black and white because it was easier to interpret. Circuit diagrams for operation of the camera system are included. The camera has been in operation for more than one year, has performed adequately, and has procured the data desired. L.S.

N67-37055# Naval Radiological Defense Lab., San Francisco, Calif.
THE FABRICATION AND USE OF HIGH RESOLUTION LITHIUM-DRIFTED GERMANIUM GAMMA-RAY DETECTORS
John P. Hurley, James M. Mathiesen, and Victor L. Da Gragnano 31 Jul. 1967 33 p refs
(USNRDL-TR-67-55; AD-655624)

Experiments designed to study the behavior of various Ge(Li) detector systems are described. Techniques of improving energy resolution are discussed. Measurements of detector response to thermal radiation are described. A series of measurements showing the variation of line width as a function of energy is discussed. Finally, the appearance of anomolous peaks in the pulse height spectra is described. Author (TAB)

N67-37075# Cekmece Nuclear Research Center, Istanbul (Turkey).
A HOME-MADE NEUTRON CRYSTAL SPECTROMETER FOR RESEARCH AND TRAINING
R. O. Akyuez, C. Cansoy, and F. Domanic Nov. 1965 15 p refs
(CNAEM-33)

In order to make experimental research in the field of low energy nuclear physics, a crystal neutron spectrometer was constructed. The energy range is between 0.025 and 6 eV. The available monochromator single crystals are Be, NaCl, ($CaCO_3$), and Pb. The minimum precise rotation of spectrometer is 1 minute of arc in Bragg angle. Two Soller type collimators, one from reactor to crystal and the other from sample to counter, are used. The net angular divergence is approximately 5 minutes of arc. The counting system consists of two channels, one of which is used for monitoring the reactor. Counter tubes are B^{10} enriched BF_3 proportional counters. The main problem in construction was to design and give precise movement to the heavy crystal shielding. Author

N67-37174* Beckman Instruments, Inc., Fullerton, Calif. Scientific and Process Instruments Div.
STUDY AND INVESTIGATION OF OPTICAL SYSTEM, PHASE II Final Report
B. D. Henderson and J. Zerucha 14 Aug. 1964 50 p refs Prepared for JPL
(Contracts NAS7-100; JPL-950880)
(NASA-CR-88500) CSCL 20F

A detailed optical design for an infrared spectrophotometer and telescope for the 3μ to 5μ wavelength range to be used in the Mars flyby spacecraft is presented. A multi-three-dimensional axis system is used to describe the monochromator and telescope. Definitions of monochromator and telescope encompass the collimating mirror, grating, image test planes, telescope objective, entrance window, and the surface of Mars. Other topics considered are the slit image position and aberrations, the image at the surface of Mars and at the entrance window, tolerances, the grating, and boundary ray areas. S.P.

N67-37182# Physikalisch-Meteorologisches Observatorium, Davos (Switzerland).
A NEW SPECTROPHOTOMETER FOR MEASURING ULTRAVIOLET SKY BRIGHTNESS AND DIRECT SOLAR RADIATION Final Scientific Report, 1 Jan. 1963–31 Dec. 1966
Paul Bener Apr. 1967 156 p refs
(Contract AF 61(052)-618)
(AFCRL-67-0410; AD-655394)

A transportable spectrophotometer for measuring ultraviolet sky brightness and solar radiation from 295 to 400 millimicrons is described. This instrument serves for a study of atmospheric scattering by comparing measured and theoretical values of intensity. Its main components are: A double monochromator Zeiss MM 12, a telescope, a photomultiplier enclosed in a cooling box and a mounting for following the sun and scanning the sky according to the astronomical and horizontal system respectively. Neutral attenuation filters are applied to bridge the interval of brightness (100,000) between sun and sky and to adapt the sensitivity to the varying sky brightness. The components of sky brightness polarized parallel and normal to the entrance slit are measured separately. An effective spectral bandwidth between 0.9 and 2.5 millimicrons is

normally applied. Mean values of the signal current are measured by means of a Keithley 610 A electrometer and a voltage-to-frequency converter. Photon counting is applied for the lowest levels of intensity. The overall accuracy amounts to plus or minus 7% for intensity and to plus or minus 3% to 5% for the ratio between sky brightness and solar radiation. TAB

N67-37185*# TRW Systems Group, Redondo Beach, Calif.
HOLOGRAPHIC INTERFEROMETRY WITH APPLICATIONS TO FLUID MECHANICS
R. E. Brooks, R. F. Wuerker, L. O. Heflinger, and C. Knox 1967 6 p Presented at the Intern. Colloq. on Gasdyn. of Explosions, Brussels, 20 Sep. 1967
(Contract NASw-1572)
(NASA-CR-73124) CSCL 20F

The slides and accompanying discussion used in a presentation on holographic interferometry and its applications to fluid mechanics are contained in this report. R.N.A.

N67-37199* Boeing Co., Seattle, Wash. Electronics Technology.
PICTURE DATA SYSTEMS ANALYSIS—LUNAR ORBITER
7 Dec. 1964 165 p refs
(Contract NAS1-3800)
(NASA-CR-66460; D2-100293-1) CSCL 14E

An analysis of the Lunar Orbiter picture data system performance was made for both nominal and off-nominal values of significant variables. Modulation transfer functions and signal-to-noise analysis of the individual and combined optical, photographic, and electronic components were used to assess their characteristics and effects on the resolution capabilities of the system. Variables studied include those related to orbital parameters, the lunar surface being photographed, the observational geometry, the environmental factors of ionizing radiation and meteoroid flux, and the communication link. Monitoring techniques for control and calibration of the photographs are described. It is shown that 1 meter surface resolution specification can be met by the high resolution camera on-axis from the nominal altitude of 46 km and a sun angle between 50° and 75°. Resolution will be degraded to less than 2 meters at the field edge. The low resolution requirement of 8 meter surface resolution will be met under favorable conditions. Author

N67-37210# Woods Hole Oceanographic Institution, Mass.
RESPONSE CHARACTERISTICS OF A SAVONIUS ROTOR CURRENT METER
Nick P. Fofonoff and Yuecel Ercan Jun. 1967 91 p ref
(Contracts Nonr-3351(00); Nonr-2196(00))
(Rept.-67-33; AD-655641)

The steady-state and dynamic characteristics of the sensors in a Savonius rotor current meter are examined to evaluate the frequency response and precision of the instrument for current measurements. Author (TAB)

N67-37225# California Univ., Livermore. Lawrence Radiation Lab.
SENSITIVITY OF PHOTO ELECTRIC DIODE DETECTOR FOR SOFT FLUORESCENT X-RAYS
J. L. Gaines, and G. R. Leipelt 27 Apr. 1967 5 p
(Contract W-7405-ENG-48)
(UCID-15164) CFSTI: HC $3.00/MF $0.65

A standard photoelectric diode detector, known as a PED or XRD-4 detector, utilizing a nickel cathode was calibrated using soft fluorescent X-rays. The experimental procedure was to remove the PED detector from the line of sight and count the number of photons at an NaI(Tl) detector. The PED detector was then inserted back into the line of sight and the current from this detector measured. The sensitivity versus energy is shown. NSA

N67-37252*# General Electric Co., Binghamton, N. Y. Avionic Controls Dept.
MICROMINIATURE RATE-OF-TURN SENSOR Final Report
S. B. Hamilton Sep. 1967 93 p refs
(Contract NAS8-20618)
(NASA-CR-88715; ACD-8569) CFSTI: HC $3.00/MF $0.65 CSCL 14B

This report describes the development, design, fabrication, and testing of a laboratory model for a single-axis vibratory angular rate sensor. The vibrating element of the sensor is a free–free metal beam of approximately a square cross-section that is mounted at its first mode nodal points, and is vibrated by piezoelectric transducers. The transducers, bonded to each of the four faces of the beam, are also used to detect changes in the direction of beam vibration due to angular rates about the longitudinal axis of the beam which is the sensitive axis. Electronics, utilizing microelectronic operational amplifiers, produce the voltages which excite the transducers, and also amplify and demodulate the sensor output signal. Author

N67-37281* Spacelabs, Inc., Van Nuys, Calif.
PROPELLANT LEAKAGE DETECTION SYSTEM Quarterly Progress Report, 1 Jun.–31 Aug. 1967
31 Aug. 1967 30 p
(Contract NAS9-6649)
(NASA-CR-65737; QPR-3) CSCL 14B

Various mechanical configurations for flow sensing were evaluated, resulting in the use of a self-heated thermistor inserted in a cylindrical sheath to assess two systems. These included the cross flow, with the cylindrical sheath perpendicular to the direction of flow; and the coaxial flow, with the sheath parallel to the direction of flow. The results show that both configurations are suitable for flow measurement. To determine the optimum mechanical configuration for low flow measurement, four basic systems were tested for sensitivity to flow rate, orientation, power requirement, and electronic arrangement. These were the cross flow, coaxial flow, folded flow path, and three-probe heater sensor. Based on the data comparison, the cross flow system was selected to measure low flow rates. M.G.J.

N67-37311# France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
HIGH RIGIDITY LOAD CELLS FOR FORCES BETWEEN 1,000 AND 50,000 daN [DYNAMOMETRES DE GRANDE RIGIDITE CAPACITE DE 1000 A 50,000 daN]
Roger Helou 24 Apr. 1967 15 p In FRENCH; ENGLISH summary
(TN-109(1967))

Design, building and calibration of a certain number of load cells two types of which are described in this note. The first type belongs to the series 20N91 to 20N97 for loads from 1,000 to 50,000 daN; it is very rigid axially and laterally. These load cells are verified in vacuum and not affected by lateral loads; they are not sensitive to temperature effects and their precision is ±1/1,000. They may be used with or without mono-or universal flexures on several-component load-cell rigs. The second type, 20N100, is very rigid axially and gives an important signal because of the use of semi-conductor strain-gages. The description and information in this note are given in view of making easier the use of this equipment. Author

N67-37355# RAND Corp., Santa Monica, Calif.
COMPARISON OF THE 3 TO 5 AND 8 TO 13 MICRON BANDS FOR TERRAIN RECONNAISSANCE, AND OPTIMIZATION OF OTHER PARAMETER VALUES
L. G. Mundie Jul. 1967 16 p refs Presented at the 15th Infrared Inform. Symp., San Francisco, 17–19 May 1967
(P-3580; AD-656699)

The relative merits of utilizing the 3 to 5 and 8 to 13 micron atmospheric windows for passive infrared reconnaissance have long been debated by the infrared community. In an effort to provide a firm basis for a discussion of this problem, the paper compares the calculated signal-to-noise values to be expected with presently available detectors operating in these wavelength regions as a function of target temperature for three atmospheric paths. The results are discussed in the light of the imagery that has been acquired utilizing the two windows, and conclusions are drawn concerning the source of seeming discrepancies. Finally, recommendations are made concerning the optimization of equipment parameter values for accomplishing specific reconnaissance objectives. Author (TAB)

N67-37368* Scientific Translation Service, La Canada, Calif.
HIGHLY SENSITIVE ACCELEROMETER [ACCELEROMETRE A GRANDE SENSIBILITE]
Michel Gay Washington, NASA, Aug. 1967 8 p refs Transl. into ENGLISH from ONERA T.P., v. 393, 1966 Presented at 12th Intern. Astronautical Congr., Madrid, 9–15 Oct. 1966
(Contract NASw-1496)
(NASA-TT-F-11185) CSCL 14B

Investigated are highly sensitive accelerometers. Following some general considerations on the particularities of this type of instrument, the solutions retained are developed. The three-directional accelerometer uses a servo-loop and a capacitance detection of the motion of a ball suspended electro-statically. The prototype has measurement ranges from $7.5 \cdot 10^{-2}$ ms^{-2} to values beyond 10^{-8} ms^{-2}. The results already obtained allow thresholds on the order of 10^{-8} ms^{-2}, with a response time of 1.5 sec. Author

N67-37384# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MULTIPLE-POINT MANOMETER WITH DYNAMIC COMPENSATION AND DISTANCE REGISTRATION [MNOGOTOCHECHNYY MANOMETR S DINAMICHESKOY KOMPENSATSIYEY I DISTANTSIONNOY REGISTRATSIYEY]
N. N. Chernov, V. I. Volkov, and K. Ye. Monakhov 27 Feb. 1967 7 p Transl. into ENGLISH from Russian Patent no. 155113 (Appl. no. 739546/26-10, 24 Jul. 1961) 3 p
(FTD-HT-67-20; AD-655354)

The patent describes a multiple-point manometer with dynamic compensation and distance registration on a printing device, the manometer having a bellows like pickup of pressures and fastened onto a weight lever, the contact arm of which is united through a coil spring and a conveyer-type pull-rod with a group shaft kinematically joined with an electric motor through a reducer, a pulse unit and an electronic memory and recording device, which for the purpose of connecting in electronic counters at a given initial pressure it is provided with a device consisting of two disks, one of which is kinematically joined with the group shaft, and the other with an electric motor and a photosensor which passes a signal for connecting in the electron counters at the moment of coinciding of the disk openings. Author (TAB)

N67-37382* IIT Industrial Labs., Fort Wayne, Ind.
HIGH RESOLUTION NIGHTTIME CLOUD-COVER RADIOMETER Quarterly Report, 1 Jan.–1 Apr. 1967
W. Wallschlaeger, R. Pownall, P. Murray, and L. Owens 31 Jul. 1967 190 p
(Contract NAS5-668)
(NASA-CR-88759; QR-12) CSCL 20F

Data from vibration, humidity, vacuum-thermal cycling, and other environmental tests on prototype model P-3 radiometer are presented. The patch suspension rings were redesigned to provide the necessary reliability under vibration conditions. A reliability program was undertaken in order to insure the confidence level of several types of transistor assemblies which were replaced on all flight model boards after they had been cleaned in an ultrasonic bath. Assembly of two flight units was nearing completion, and testing is ready to begin on model F-5 shortly after delivery of P-3. L.S.

N67-37404*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
FEASIBILITY DESIGN OF AN INSTRUMENT SYSTEM FOR MEASUREMENT OF HORIZON RADIANCE IN THE CO_2 ABSORPTION BAND: HORIZON DEFINITION STUDY
John C. Carson, Joseph S. Titus, Alden J. Mooers (Control Data Corp.), Ralph W. Peterson (Control Data Corp.), Charles N. West et al May 1967 585 p refs Prepared jointly with Control Data Corp.
(Contract NAS1-6010)
(NASA-CR-66429) CFSTI: HC$3.00/MF$0.65 CSCL 14B

A feasibility design of an instrument system to collect data of the earth's horizon radiance profile in the carbon dioxide absorption band has been developed. This system is the prime payload component of the Horizon Definition Study (HDS) spacecraft. The data gathered through the experiment performed by the spacecraft-borne instruments is to be used in determining the ultimate, obtainable horizon sensor performance and in increasing knowledge of the physics of the earth's atmospheric emission. A radiometer, two starmappers, and two sun sensors constitute the primary elements of the experiment package. Radiance profile data is referenced to a geocentric coordinate system and, thus, instantaneous attitude and position of the data-taking instrument must be known. While position information is obtainable from the ground, attitude must be measured from within the spacecraft. A passive starmapper, with a slit reticle and a photomultiplier detector, and a sun sensor, are the major components of the attitude determination system. Author

N67-37426# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
DOSIMETRY WITH TIME READ-OUT
M. Sidran Jun. 1967 14 p refs
(RE-293)

Outlined are the general principles of a novel radiation dosimeter which indicates, in addition to the dose, the time elapsed since exposure. The procedure for its use had been demonstrated previously with an infrared-stimulable phosphor serving as the dosimeter. Other techniques for time readout dosimetry are also discussed. The stored information can be released in many ways, e.g., by mechanical shock, heat, electric fields, or infrared light. It can be detected in the form of optical, electrical, or magnetic energy. The period during which time readout is possible can be adjusted through proper fabrication of the dosimeter. This device has applications to space experiments, and to personnel protection. Author

N67-37427# California Univ., Berkeley. Hydraulic Engineering Lab.
NON-LINEAR WAVE EFFECTS ON TIDE GAGES
Ralph H. Cross May 1967 32 p refs
(Contract DA-CW-72-67-C-0002)
(HEL-16-2; AD-655255)

For tide stations at locations subject to moderate or high waves, the damping device is not linear, since the flow through the orifice is approximately proportional to the square root of the differential head. The purpose of this paper is to investigate the non-linear interaction between this filter and second-order wave theory, specifically estimating the effect of this interaction on the water level inside the stilling well for a variety of water depths, wave heights, wave periods, and orifice depths. Author (TAB)

N67-37453*# Wichita State Univ., Kans.
A NON-ROTATING VORTICITY METER
Melvin H. Snyder, Jr. and Michael C. McMahon Washington, NASA, Oct. 1967 27 p refs
(Grant NGR-17-003-003)
(NASA-CR-887; AR-66-3) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A non-rotating strain gage type vorticity meter has been designed for the survey of the flow field behind delta wings. Calibration results for a partially instrumented meter are presented. Although these results are in the direction predicted by theory, the calibration technique needs to be improved. The concept of a non-rotating vorticity probe has been demonstrated to be feasible and further development should produce an instrument valuable for rapid mapping of extensive flow fields. Author

N67-37484# Sandia Corp., Albuquerque, N. Mex.
THE THUMPATRON: AN INSTRUMENT FOR DETERMINING THE DIRECTION OF POLARIZATION OF FRAGILE PIEZOELECTRIC SAMPLES
G. E. Ingram Jun. 1967 10 p refs
(Contract AT(29-1)-789)
(SC-DR-67-494) CFSTI: HC $3.00/MF $0.65

An instrument which has been used for a number of years in nondestructive testing of many types of piezoelectric and ferroelectric materials is described. The instrument detects the initial polarity of the rapidly fluctuating electric fields generated by these materials when they are subjected to a low amplitude plane-compressive strain pulse. The strain pulse is created by a gentle mechanical thump propagating as a plane wave into the specimen from an adjacent solid electrode. This dynamic force application technique has eliminated the sample breakage problem which was prevalent during conventional static testing. Shear forces, common in static testing, are eliminated, thus reducing the polarity uncertainty problem. Author (NSA)

N67-37485# Idaho Nuclear Corp., Idaho Falls.
SEMICONDUCTOR COUNTING SYSTEM FOR HIGH-RESOLUTION ALPHA-PARTICLE SPECTROSCOPY
R. N. Chanda and R. A. Deal Jun. 1967 16 p refs
(Contract AT(10-1)-1230)
(IN-1082) CFSTI: HC $3.00/MF $0.65

A high-resolution, semiconductor, alpha-particle, spectroscopy system was designed. The system employs a low-noise FET charge-sensitive preamplifier having a noise contribution of 0.77 keV silicon equivalent at 0 pf and a noise-capacitance slope of 0.028 keV/pf of input capacitance. The detector remains in constant vacuum during changing of samples, and provision is made for cooling both the detector and first stage of the preamplifier. When operated at 0°C, resolutions of <12 keV FWHM were obtained for 5.8-MeV α particles. Author (NSA)

N67-37506# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE INCREASE OF THE RELIABILITY AND ACCURACY OF POTENTIOMETRIC PICKUPS OF GYROSCOPIC INSTRUMENTS [POVYSHENIYE NADEZHNOSTI I TOCHNOSTI POTENTSIOMETRICHESKIKH DATCHIKOV GIROPRIBOROV]
Z. F. Urazayev and V. Yu. Shishmarev 24 Apr. 1967 38 p Transl. into ENGLISH from Tr. Aviats. Tekhnol. Inst. (Moscow), no. 59, 1964 p 3–4, 111–137
(FTD-MT-65-301; TT-67-62354; AD-655363)

The article briefly reviews the modern theory of instrument reliability and discusses the use of potentiometers in aircraft instruments in detail from this viewpoint. It is pointed out that the most vulnerable element in a potentiometer is the electrical contact between the potentiometer winding and the wiping contact. Contact failure is the most serious reliability problem in automatic pilot instrumentation. The design of a reliable contact is therefore discussed in detail and a few design examples are described. The possibility of increasing the reliability by providing a second parallel contact is examined and its effect on the potentiometer performance and error is illustrated by specific examples. The reasons for contact failure are discussed, and the case when two parallel contacts are used, one of which is displaced with respect to the other by either one turn or a half a turn of the potentiometer winding, is examined in detail. TAB

N67-37511*# Ling–Temco–Vought, Inc., Dallas, Tex. LTV Research Center.
CALIBRATION OF PHOTOCON PRESSURE TRANSDUCER
B. Brown and J. J. Van Houten Mar. 1967 18 p ref
(Contract NAS1-5652)
(NASA-CR-66369; TR-0-71200/7TR-116) CFSTI: HC $3.00/MF $0.65 CSCL 14B

Utilizing the techniques of investigating the calibration of microphones to be used for sonic boom evaluation, three Photocon microphone systems have been calibrated. This calibration includes a measurement of the frequency response of the transducers obtained by use of an infrasonic pistonphone in the frequency range from 0.01 Hz to 10 Hz. The effect on transducer sensitivity by changes in transducer balance sensitivity was evaluated and found to vary considerably with balance meter reading. An electrostatic actuator was used to obtain both the steady state response of the transducer as well as the rise time and overshoot characteristic to a step function. Finally, utilizing the electrostatic actuator system developed to produce N-wave pressures on a microphone, the Photocon transducer response to an ideal N-wave was obtained. Author

N67-37567# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
INVESTIGATION OF RECEIVERS DESIGNED FOR THE MEASUREMENT OF ULTRAVIOLET RADIATION IN THE UPPER ATMOSPHERE AND IN OUTER SPACE [ISSLEDOVANIYE PRIYEMNIKOV PREDNAZNACHENNYKH DLYA IZMERENIYA UL'TRAFIOLETOVOGO IZLUCHENIYA V VERKHNEY ATMOSFERE ZEMLI I KOSMICHESKOM PROSTRANSTVE]
V. T. Tayt, V. G. Kurt, and V. V. Katyushina 12 Sep. 1967 2 p Transl. into ENGLISH from Kosmicheskiye Issledovaniya, v. 5, no. 2, 1967 p 280–284
(Contract NAS5-12487)
(ST-IN-AI-10646) CSCL 03A

This paper presents the description of a vacuum diffraction ultraviolet monochromator for the investigation of spectral sensitivity of radiation receivers, such as photomultipliers, photon counters, and ionization chambers. A flow hydrogen lamp was used as the light source. Its spectrum is presented along with a table of wavelengths of certain lines. The registering circuit assures only the recording of the investigated radiation receiver's signal ratio to the signal of the reference photomultiplier with sodium salicylate-coated photocathode. A comparison of the photomultiplier with a vacuum thermocouple allows realization of the radiation receiver's absolute calibration. Author

N67-37588# Midwestern Universities Research Association, Stoughton, Wis.
DESIGN OF IONIZATION SPECTROMETERS USING IRON AND SCINTILLATORS, FOR THE DETECTION OF HADRONS IN THE 100–1000 BeV RANGE
D. E. Lyon, Jr. (Michigan Univ.) and A. Subramanian (Tata Inst. of Fundamental Res., Bombay) May 1967 22 p refs
(MURA-725) CFSTI: HC $3.00/MF $0.65

Design specifications for total absorption spectrometers using plastic scintillators and iron to detect and measure the energies of hadrons in cosmic radiation in the energy range 100–1000 BeV are given, based on results obtained with an experimental spectrometer set up and operated at Echo Lake, Colorado (elevation 10,600 ft.) during the fall and winter of 1966–67. With a sample of 2000 events to study, it was concluded that the energy resolution with such a device is ±20%, if the spectrometer is constructed using a total thickness of iron of at least 1000 gm/cm^2, and using plastic scintillator probes with a thickness of less than 2 gm/cm^2 to sample the nuclear cascade development, separated at most by 100 gm/cm^2 of absorber material and placed with this frequency throughout the entire thickness of the absorber. Author (NSA)

N67-37616*# TRW Systems, Redondo Beach, Calif.
TEMPERATURE CONTROL FLUX MONITOR FOR MARINER MARS 1969 Final Report
9 Dec. 1966 112 p Prepared for JPL
(Contracts NAS7-100; JPL-951726)
(NASA-CR-88748; TWR-06988-6002-R000) CFSTI: HC $3.00/MF $0.65 CSCL 14B

This report contains the definition study and preliminary design of the Temperature Control Flux Monitor (TCFM) and constitutes a compendium of preliminary design requirements and supporting analyses generated during the study and design phases. Design considerations are presented for the transducer and the electronic system. A transducer thermal analysis includes radiative heat addition and loss, guard temperature, conductive heat transfer, and overall heat balance. Error analyses were conducted for the aperture area, the electric and thermal properties of the cone, the Stefan Boltzmann constant, the radiant–ohmic power non-equivalence, temperature sensor self-heating, and the thermal control monitoring system. An analog system study covers temperature control and automatic data converter operation. As a result of the design studies, it is concluded that the essential target requirements for the TCFM can be met within the existing state-of-the-art techniques; furthermore, this can be achieved without additional or undue constraints on the Mariner spacecraft system. K.W.

N67-37624# National Aeronautical Establishment, Ottawa (Ontario). Flight Research Section.
FLIGHT EVALUATION OF AN INFRARED SPECTROMETER AS A CLEAR AIR TURBULENCE DETECTOR
G. K. Mather 16 May 1967 86 p refs Prepared for FAA
(LR-477; FAA-RD-66-70)

A prototype of a infrared spectrometer proposed as a clear air turbulence detector has undergone initial flight tests. Advance warning of up to 8.5 nautical miles before interception of horizontal atmospheric temperature variations were recorded. A high correlation between temperature variations and mountain waves and/or turbulence was found during the tests. The necessity of pitch stabilizing such a device against spurious aircraft attitude changes has been demonstrated. Author

N67-37642# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
GRAVITATIONAL CLINOMETER [GRAVITATSIONNYY EKLIMETR]
N. I. Kusherbayev Jul. 1967 10 p refs Transl. into ENGLISH from Razved. Geofiz. Nedr (Moscow), no. 8, 1965 p 114–118
(ACIC-TC-1218; TT-67-62340; AD-655707)

As is generally known, when the influence of the terrain relief upon the readings of gravimeters is taken into account, then the region surrounding the points of observation should be divided into several elementary sections. The vertical component of attraction of an elementary section can be expressed by an angle at which any element of the relief can be observed. This served as a basis for the construction of a gravitational clinometer, which in the absence of large scale topographic maps, makes it possible to determine regional corrections at a distance of up to 50 m from the point of observation. The use of this instrument makes the determination of corrections simpler than when leveling is applied for this purpose. TAB

N67-37686# Liege Univ. (Belgium). Institut d'Astrophysique.
ROCKET EXPERIMENTS S-18 Final Report
[1966] 16 p Sponsored by ESRO
CFSTI: HC $3.00/MF $0.65

The light phenomena accompanying the release of ammonia into the upper atmosphere is studied. The data obtained by the various spectrographs (Ebert–Fastie, Huet, and nebular spectrograph) and the photomultiplier measurements are listed. Some photographic results are given. It is concluded that NH_2 emissions have been detected by several spectrographs and photometers as well as some traces of NH emission in the ultraviolet. The main emission feature in the luminous ring is, however, probably due to diffusion of sunlight. ESRO

N67-37691# Brookhaven National Lab., Upton, N. Y.
AGS INJECTOR BEAM MONITORING SYSTEM
A. Otis, R. Larson, R. Lockey, B. De Vito, and A. van Steenbergen 1 Jun. 1967 29 p refs
(BNL-11493) CFSTI: HC $3.00/MF $0.65

The performance of the AGS depends critically on the linac beam characteristics such as beam intensity, proton momentum, momentum spread and beam transverse phase space distribution. These parameters are measured by pulse deflection of the 50-MeV proton beam into a separate analyzing channel in which continuous beam analysis and monitoring is possible without interruption of regular AGS operation. In addition to a general description of the linac-synchrotron beam transport and analyzing system, details of the momentum spread and monitoring system are presented. Author (NSA)

N67-37732* Farnham (Frank C.) Co., Philadelphia, Pa.
GAMMA SPECTROMETRY WITH SEMICONDUCTOR DETECTORS
G. Riepe and H. Petri Washington, NASA, Aug. 1967 14 p refs Transl. into ENGLISH of a German Report
(Contract NASw-1497)
(NASA-TT-F-11202; JUL-308-RB) CSCL 18D

Lithium-drifted germanium and silicon semiconducting detectors were compared with a thallium–activated sodium iodide crystal scintillation counter in a multiple channel spectrometer for gamma spectrometry. Observed were absorption probability, resolution, and time constant of the rising pulse. Obtained resolution values proved the germanium–lithium detector superior to the scintillation counter; but absorption ability remained behind the performance of the sodium iodide crystal. The time constant of the rising pulse for the germanium sensor was about 10 times shorter than that for the sodium iodide counter. Author

N67-37762# Los Alamos Scientific Lab., N. Mex.
READING SCHEDULES FOR THE MSA PARTICLE SIZE ANALYZER
Robert E. Cowan and Verna L. Gardiner 14 Jun. 1967 64 p
(Contract W-7405-ENG-36)
(LA-3692) CFSTI: HC $3.00/MF $0.65

Reading schedules for the MSA Particle Size Analyzer were calculated using a digital computer. A total of 1221 schedules are tabulated to cover K values between 0.80 and 40.0×10^4. Author (NSA)

N67-37782# Michigan Univ., Ann Arbor. Dept. of Internal Medicine.
A NEW AUTOFLUOROSCOPIC CAMERA
William H. Beierwaltes, Gordon M. Brown, Lawrence W. Jones, and F. Deaver Thomas May 1967 26 p refs Prepared jointly with Bendix Corp.
(Grants NIH CA-05134-05; ISOI FR053834-04)

Details are given on a prototype scintillation camera system for nuclear medicine. Essentially, the system consists of a NaI crystal to convert gamma rays to visible light quanta which are then focused by a lens onto the photocathode of a three-stage image intensifier. The intensifier amplifies the light from each scintillation pulse in the NaI crystal to a level where it can be recorded on film. Both pinhole and multichannel collimators are used. The pinhole is most useful when objects are imaged at magnifications different from unity or when the object must be spaced some distance from the detector (e.g., deep organs). The multichannel collimators are used for viewing large organs at unity magnification. The image detector consists of a thick scintillation single crystal, a fast objective lens, a high gain optical image intensifier, and a fast photographic recording system. Limitations on the detection efficiency, inherent resolution, and sensitivity of the image detector are assessed. System improvements are suggested and it is felt, that with these modifications, the camera will image satisfactorily at the radionuclide tissue concentrations usually present in diagnostic tests. M.G.J.

N67-37788*# TRW Systems, Redondo Beach, Calif.
TEMPERATURE CONTROL FLUX MONITOR FOR MARINER MARS 1969 Definition Study Report
9 Dec. 1966 60 p Prepared for JPL
(Contract JPL-951726)
(NASA-CR-88746; TRW-06988-6001-R000) CFSTI: HC $3.00/MF $0.65 CSCL 14B

This report presents the design of the Temperature Control Flux Monitor (TCFM) developed for the flight adaptation of the JPL Absolute Cavity Radiometer concept. The study defines the control and measurement circuitry necessary to meet Mariner Mars 1969 spacecraft interface requirements. An approach is described which is judged to be best capable of meeting the requirements of long-term stability, telemetered accuracy, and reduced packaging volume. The TCFM electronic control assembly design presented here is based on circuit techniques used in digital computer technology. A dynamic analysis was performed to assure soundness of design of the temperature control approach in the TCFM electronic system. The transducer design was briefly studied to assure overall compatibility of the TCFM system. Also described is the operational ground support equipment for preparing the TCFM for flight at the system test complex and at the launch complex. K.W.

N67-37868*# Bendix Corp., Davenport, Iowa. Pioneer-Central Div.
DEVELOPMENT OF OPTICAL LIQUID LEVEL SENSOR FOR USE IN LIQUID HYDROGEN Final Report, Jun. 1964–Oct. 1965
P. Lenker, R. Resh, W. Dray, N. Hosford, and R. Shearer 8 Jun. 1966 89 p *Its* Publ. No. 3464-1-66
(Contract NAS8-11644)
(NASA-CR-88885) CSCL 14B

Circuit design, component survey data, assembly, and sensor testing operations are described. Three complete level sensors were tested in accordance with specifications, including immersion in liquid hydrogen. Efforts to satisfy electrical response time requirements are cited. In general, development goals for a one-piece optical liquid sensor for operation in LH_2 were met. Recommendations are given for accomplishing further sensor design improvements. Various test data statistics are included along with curve tracer photographs of semiconductor components during temperature tests. E.C.

N67-37883*# Texas Univ., Austin.
RESEARCH ON DIGITAL TRANSDUCER PRINCIPLES, VOLUME 1 Semiannual Report, 1 Jul.–31 Dec. 1966
William H. Hartwig 31 Dec. 1966 98 p refs
(Grant NGR-44-012-043)
(NASA-CR-88867; SAR-1) CFSTI: HC $3.00/MF $0.65 CSCL 14B

Several workable digital transducer designs are proposed and a new discontinuous mechanism in metal-insulator-semiconductor thin film tunneling structures is examined. The workable designs include digital resistance/temperature and resistance/magnetic field transducers for cryogenic environments and a capacitor/temperature transducer for the range from 80°K to well above 400°K. The discontinuity in the voltage–current characteristic of a tunneling MIS thin film device is shown to be caused by formation of a depletion zone in the semiconductor. The theory of tunneling in MIM structures is given and modified to fit the MIS data. A design and analysis procedure is introduced for a tunneling digital voltage/current transducer. The capacity of these structures is essentially independent of frequency over the range 10–100 Kc indicating a frequency dependent space charge is present in the depletion zone. The capacity–voltage relation is shown to depend upon the semiconductor impurity and defect distribution normal to the surface. Charge transport mechanisms in thicker films of Si_3N_4 show a bulk-limited process dominates over the tunneling current. More exotic dielectric materials for future tunneling digital transducers are discussed. Author

N67-37888# Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics.
DESIGN AND PERFORMANCE OF A SIZE-SEPARATING AEROSOL CENTRIFUGE FACILITATING PARTICLE SIZE SPECTROMETRY IN THE SUBMICRON RANGE
W. Stoeber [1967] 13 p refs Presented at the Intern. Atomic Energy Agency Symp. on Instr. and Tech. for the Assessment of Airborne Radioactivity in Nucl. Operations, Vienna
(Contract W-7405-ENG-49)
(UR-49-778; CONF-670704-4) CFSTI: HC $3.00/MF $0.65

In order to facilitate a higher sampling rate without abandoning the principle of complete particle separation, efforts were made to design two instruments complying with these requirements. A prototype of one of these devices, which is still in the experimental stage, is shown. This model retains the essential features of the conifuge except for the entrance ports of both clean air and aerosol. Theoretical and experimental results for the particle deposition pattern and calibration curves for particle deposition patterns at different operating conditions are shown. NSA

N67-37898# Uppsala Univ. (Sweden). Inst. of Physics.
A BETA SPECTROMETER ARRANGEMENT FOR MEASURING CONVERSION ELECTRON SPECTRA FROM (n, γ) REACTIONS AT THE R2 REACTOR
A. Baecklin 1967 21 p refs Sponsored by Swed. Atomic Res. Council
(LF-16; NP-16831)

The 50 cm radius double focusing spectrometer for measuring (n,e⁻) spectra was modified and connected to the Swedish research reactor, R2, at the research center, Studsvik. The equipment forming the neutron beam was reconstructed, which together with some modifications of the target and detector has considerably increased the sensitivity of the spectrometer. Author (NSA)

N67-37993# Del Electronics Corp., Mount Vernon, N. Y.
SYSTEM FOR LARGE VOLUME AEROSOL SAMPLING IN THE STRATOSPHERE USING ELECTROSTATIC PRECIPITATION

Leonard R. Solon, Pedro Lilienfeld, and Hugo J. Di Giovanni Dec. 1966 76 p
(Contract AT(30-1)-2363)
(TID-23860) CFSTI: HC $3.00/MF $0.65

An instrumental system for securing aerosol samples in the stratosphere by electrostatic precipitation was developed. The system is designed to be balloon borne to altitudes between 30 km and 45 km and to collect with high efficiency the aerosol content of the stratosphere at these altitudes. Volumetric sampling rates of one meter^3/sec^{-1} ambient air are obtained with the sampling configuration with collection efficiency in excess of 95 percent for particles between .01 microns (mmd) and 2 microns (mmd). Specially developed associated instrumentation for altitude and air flow measurement points to an important versatility in the application of gas discharges for low-pressure (or high altitude) altimetry and anemometry over a very wide range of air densities and temperatures. The theory, operation, and performance of the aerosol sampling system and associated subsystems are described. Certain new observations of low-density corona physics phenomena are reported and potential applications to other areas of research and technology are indicated. Author (TAB)

N67-38008 United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
CALIBRATION DRIFT EFFECTS IN NICKEL-ALLOY THERMOCOUPLES
R. A. Evans and J. Holt 1967 37 p
(TRG-1510(R)) HMSO: 5s 6d

Calibration drift tests have been carried out on nickel-alloy thermocouples at temperatures from 200°C to 650°C, with temperature profiles typical of AGR and Magnox reactors. The experiments have shown that calibration drift does not take place below 280°C, but can reach +1 to +4 degC in 100 days at 400°C. It is deduced that this drift takes place in the positive (Chromel) leg of the thermocouple. It is shown that drifts at 400°C can be prevented by heat treatment of the whole cable before putting into service. Author

N67-38022# Sylvania Electric Products, Inc., Mountain View, Calif. Electronic Defense Labs.
MAGNETIC TAPE RECORDING HANDBOOK
James A. Howard and Lester N. Ferguson Hewlett-Packard Co., Palo Alto, Calif., Aug. 1967 43 p ref *Its* Appl. Note 89
(Contract DA-28-043-AMC-01829(E))
(AN-89)

This handbook contains information on the theories and techniques of magnetic tape recorders. Some practical considerations related to the application and limitations of the direct and FM recording processes are given. The handbook discusses the history of magnetic recording, magnetic recording principles, tape recorder heads, tape transport mechanisms, electronis, magnetic tape, and special techniques such as pulse recording, predetection recording, and dubbing. R.N.A.

N67-38026# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.
FAST AMPLITUDE AND TIME PULSE DISCRIMINATION IN CONNECTION WITH SEMICONDUCTOR DETECTORS
C. Zajde Nov. 1966 25 p refs Transl. into ENGLISH from Onde Elec. (Paris), v. 46, 1966 p 819-828
(NP-TR-1552) CFSTI: HC $3.00/MF $0.65

A time discriminating and amplitude analyzing system was developed which has the advantage of being simple while having a high performance with respect to speed and dynamic range. The characteristics obtained are particularly suited to the use of semiconductor detectors. It was also shown that such an arrangement is essential even in circumstances where the object is not to carry out a fine amplitude analysis, with the aid of detectors using photomultipliers for example, but where it is nevertheless necessary to know the real amplitude spectrum so as to be able to determine thresholds rapidly and reliably. Finally, methods of testing detector chains with the aid of light-emitting diodes are discussed. Author (NSA)

N67-38049*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PRELIMINARY RESULTS FROM AN AIRCRAFT-BORNE MEDIUM RESOLUTION RADIOMETER
B. A. Sparkman, G. T. Cherrix, and M. S. Tobin Sep. 1967 35 p refs
(NASA-TM-X-55918; X-622-67-445) CSCL 20F

Fourteen flights of the NASA Convair 990 research aircraft were conducted carrying a five-channel, madium resolution, scanning radiometer. Surface temperature data plots from the 10 to 11 micron channel of the radiometer over areas of southern California which show differences in temperatures of lava, deserts, and salt beds are presented. These temperatures also show the large effect haze layers have on 10 to 11 micron measurements. An increase in the spectral reflectance of an ocean surface caused by the kelp beds off the coast of San Diego is shown. Bidirectional reflectances of stratocumulus clouds and ocean surfaces were measured with the 0.2 to 4 micron channel of the radiometer. These measurements were made in four azimuthal directions with respect to the principal plane of the sun. Values of bidirectional reflectances obtained agree well with those obtained during an earlier series of flights. Author

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N67-38702# Sperry Rand Corp., Blue Bell, Pa. Univac Div.
RELIABILITY TEST PROGRAM OF ULTRASONIC FACE DOWN BONDING TECHNIQUE Final Report, 10 Nov. 1966-31 Jan. 1967
Robert P. Moore Griffiss AFB, N. Y., RADC, Jun. 1967 94 p refs
(Contract AF 30(602)-3921)
(RADC-TR-67-138; AD-655781)

A study was made to determine the overall reliability of its face-down-bonding process and to determine whether the bonding process damages the chip. The ultrasonic direct-bonding process was used to fabricate approximately 900 test samples for this study. Samples were subjected to the following tests: sheer, mechanical shock, thermal shock, vibration, centrifuge, high-temperature storage, elevated-temperature back bias, step stress and comparison, and temperature and humidity. Defective units were examined for causes of failure. The test results indicate that the stresses applied during bonding do not affect circuit operation. The bond failure rate was high, but the distribution of failures suggests that this was due to inadequate substrate process control rather than inherent problems with face-down bonding. The substrate interconnect wires corroded in high-temperature and high-humidity ambients. Several potential solutions to this problem are suggested. Author (TAB)

N67-36734*# Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR 3/8-INCH RELIEF VALVE SAGE ENGINEERING COMPANY PART NUMBER 1-2044
B. J. Coccaro 3 Apr. 1967 29 p
(Contract NAS8-4016)
(NASA-CR-88556; TR-RE-CCSD-FO-1132-3) CFSTI: HC $3.00/MF $0.65 CSCL 13K

Summary results are presented on tests performed to determine the reliability of a spacecraft component. Tested were three designated specimens of relief valve 75M02172-8, a 3/8-inch, mono-directional flow valve used to prevent over-pressurization of the 1250 psig GN_2 swing arm 2 umbilical release system on valve panel 5. During normal operation, the valve is opened by GN_2 flow and is closed by a spring. Visual and dimensional inspections were made. R.U.

N67-36791*# Chrysler Corp., New Orleans, La. Space Div.
GLOBE VALVE, 3/8-INCH, 6000 PSIG CONTROL COMPONENTS INCORPORATED, PART NUMBER MV6306T-P Test Report
G. Collins 30 Jun. 1967 61 p
(Contract NAS8-4016)
(NASA-CR-88554; TR-RE-CCSD-FO-1116-3) CSCL 13K

The valve is used in the pneumatic supply system at Launch Complex 34 of the John F. Kennedy Space Center. The operating medium is nitrogen or helium. Operational and environmental requirements of one specimen were determined in the following tests: (1) receiving inspection; (2) proof pressure; (3) functional, flow, and surge; (4) low and high temperatures; (5) sand, dust, and salt fog; (6) cycle; and (7) burst. K.W.

N67-36797* Chrysler Corp., New Orleans, La. Space Div.
SOLENOID VALVE, 3/8-INCH, 3-WAY FLODYNE CONTROLS INC., PART NUMBER 3A37S Test Report
G. Collins 23 May 1967 72 p
(Contract NAS8-4016)
(NASA-CR-88557; TR-RE-CCSD-FO-1130-3) CSCL 13K

The solenoid valve is located in the pneumatic distribution system valve panel at Launch Complex 37B of the John F. Kennedy Space Center to provide backup closing control to the LOX prevalves; it is also used at other locations at Launch Complexes 34 and 37B. Operational and environmental requirements of three specimens were tested. The following tests were performed: (1) receiving inspection; (2) proof pressure; (3) functional; and (4) high and low temperatures. K.W.

N67-36838 Martin Co., Baltimore, Md.
GAS BEARING DESIGN STUDY Final Engineering Report
J. J. Zaloudek Oct. 1966 84 p
(ER-14386)

This report summarizes the investigations made on porous air bearings. As part of this development a fabrication study was performed on numerous porous materials. Porous journal bearings were constructed by various means and tested for load carrying capability, power consumption, air gap, and yaning torque. The fabrication study yielded several feasible methods for constructing porous bearings and achieving porosity control, and laboratory testing of porous bearings yielded a set of design curves. Investigations were also made on conventional cylindrical bearings to determine their design limitations, and theory investigations were conducted for porous bearings in an effort to obtain complete design criteria. The results indicate that the support per unit flow of porous bearings is approximately 200 times better than the conventional closed surface bearings. Author

N67-36995 Waterloo Univ. (Ontario). Dept. of Mechanical Engineering.
MECHANICS OF SHEET FORMING
M. J. Hiller 1967 245 p refs

The mechanics of metal flow and failure pertaining to sheet forming is discussed, emphasizing yield and flow phenomena in plastically deforming metals and the mechanics of failures, necking, and wrinkling. Metal plasticity is approached from the point of view of continuum mechanics. Details are also given on plastic anisotropy and instability, sheet forming rates and operations, and ductility, buckling, and drawing. Plastic flow, flow patterns, and flow properties are stressed. N.E.N.

N67-37022* Chrysler Corp., New Orleans, La. Space Div.
GLOBE VALVE, 2-INCH, 6000 PSIG, CONTROL COMPONENTS, INC. MODEL NO. 445, NASA DRAWING NUMBER 75M14693 PGLV-1 Test Report
G. Collins 31 Mar. 1967 80 p
(Contract NAS8-4016)
(NASA-CR-88620; TR-RE-CCSD-FO-1120-3) CSCL 13K

This report presents the results of tests performed on one specimen of the globe valve 75M14693-PGLV-1. The following tests were performed: receiving inspection, proof pressure, functional, flow, surge, low temperature, high temperature, sand and dust, salt fog, cycle, seat erosion, and burst. The specimen's performance was in accordance with the specification requirements. Author

N67-37025* Chrysler Corp., New Orleans, La. Space Div.
PNEUMATIC FILTER, 3/8-INCH, PERMANENT FILTER CORPORATION PART NUMBER 10813, NASA DRAWING NUMBER 10437650 Test Report
C. G. Schibler 14 Feb. 1967 88 p
(Contract NAS8-4016)
(NASA-CR-88615; TR-RE-CCSD-FO-1006-3) CSCL 13G

The results are presented of tests performed on three samples of the pneumatic filter 10437650. The following tests were performed: receiving inspection, proof pressure, bubble point, low temperature, high temperature, flow, surge, vibration, salt fog, dirt holding and collapse pressure, final inspection, and burst. Collectively, the performance of the specimens was in accordance with the specification requirements throughout the test program. It was noted, however, that the specification allows 2-psi differential pressure for 10 cfm at 6000-psig inlet pressure and the actual differential pressure for 3500 scfm at 6000-psig inlet pressure was 470 psi. The test results were confirmed by parallel testing a similar permanent filter. The cases of two filters failed structurally at 24,000 psig. Author

N67-37036* Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR ANGLE VALVE, 1/2-INCH, COMBINATION PUMP AND VALVE CO. MODEL 371, DRAWING NUMBER C-6480, NASA DRAWING NUMBER 10428534
Darrell W. Miller 1 May 1967 67 p
(Contract NAS8-4016)
(NASA-CR-88550; TR-RE-CCSD-FO-1124-3) CSCL 13K

This report presents the results of tests performed on one specimen of the angle valve 10428534. The following tests were performed: receiving inspection, proof pressure, functional, flow, surge, low temperature, high temperature, life cycle, and burst. Author

N67-37111# Rocky Flats Div., Dow Chemical Co., Golden, Colo.
TECHNIQUES FOR THINNING PLUTONIUM FOR TRANSMISSION ELECTRON MICROSCOPY

Arvel W. Brewer 3 May 1967 8 p refs
(Contract AT(29-1)-1106)
(RFP-899) CFSTI: HC $3.00/MF $0.65

Equipment and techniques used to prepare thin films of Pu for electron microscopy are described. Specimens 10×18 mm are cut from bulk foil of Pu-1 wt % Ga 0.003 in. thick, clipped to holders, and subjected to the action of a jet of electrolyte circulating through hollow cathodes and impinging simultaneously on both sides of the specimens. The method reduces preferential attack which occurs during ordinary electropolishing. Operations are conducted in an A type satellite glove box. NSA

N67-37162# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SOME PROBLEMS OF FUSION WELDING TITANIUM AND ITS ALLOYS [NEKOTORYYE VOPROSY SVARKI PLAVLENIYEM TITANA I YEGO SPLAVOV]
G. L. Petrov, M. D. Shchipkov, A. I. Lebedev, and A. S. Yazykov *In its* Phys. Met. of Titanium 30 Dec. 1966 p 457–474 refs (See N67-37121 22-17)

Investigated were the sources of oxygen and hydrogen saturation of titanium seams, and the possibility of redistribution of these gases at the boundaries of the α and β crystals during welding and of residual deformations during argon arc welding of titanium alloys. It was found that protection by argon does not prevent titanium oxidation during fusion welding, even when there is no air present. On the basis of tests, it is noted that the initial hydrogen concentration in the filling wire greatly affects the hydrogen concentration in the welded metal. Calculations found that the maximum difference in oxygen and hydrogen concentration at the phase boundary is very low. The paper concludes that hydrogen may either be introduced into or removed from the titanium and titanium alloys depending on the partial pressure of the hydrogen in the gas phase. Author

N67-37163# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SUBMERGED DOUBLE-ARC WELDING OF TITANIUM ALLOY SEMIFINISHED PRODUCTS OF MEDIUM AND LARGE THICKNESS [DVUKHDUGOVAYA SVARKA POD FLYUSOM POLUFABRIKATOV IZ TITANOVYKH SPLAVOV SREDNIKH I BOL'SHIKH TOLSHCHIN]
S. M. Gurevich and S. D. Zagrebenyuk *In its* Phys. Met. of Titanium 30 Dec. 1966 p 475–482 (See N67-37121 22-17)

A method for automatic and semiautomatic welding under a flux uses two electrode wires placed one behind the other and shifted crosswise transversely at the joint axis. Tests showed that the second (rear) electrode should be located at the intersection of the tangents passing from the first electrode to the contour of the molten bath. The amperage for welding should not be over 600–700 amp. The distance between the electelectrodes along the weld joint is 35–45 mm, and across the joint 8–12 mm. Direct current of reverse polarity is used, either from one 1000-amp generator or two separate ones. Tests of the mechanical properties of weld joints produced in this way indicate that the weld metal has the same strength as the base metal Author

N67-37227# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
METHOD OF PUMPING OF VACUUM SYSTEMS
Ye. N. Martinson and V. I. Plechev 27 Feb. 1967 6 p Transl. into ENGLISH from Russian Patent no. 164920 (Appl. no. 809519/24-6, 21 Dec. 1962) 2 p
(FTD-HT-67-17; AD-656564)

The article describes a method of pumping out vacuum systems with the aid of sorption pumps, which for the purpose of removing inert gases and attaining a higher vacuum, the system of periodically flushing out with gaseous nitrogen is used. Author (TAB)

N67-37229# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PRODUCTION OF WELDED TUBES FROM TITANIUM AND ITS ALLOYS
F. Ye. Tret'yakov, R. V. Golovkin, and V. Ya. Gol'berg 11 May 1967 55 p refs Transl. into ENGLISH of the book "Proizvodstvo Svarnykh Trub Iz Titana i Yego Splavov" Moscow, Izdatel'Stvo Metallurgiya, 1964 p 1–54
(FTD-MT-65-27; AD-656566)

The technology of the industrial process of the manufacture of welded straight-seam tubes from titanium and its alloys is presented; the essence of two new processes for the production of tubes from titanium - argon-arc and high-frequency welding - is shown. The construction of units for preparation of strip in the flow of tube-welding machine, protective chamber, and semiautomatic welding torch is indicated. Special features of transfer equipment, welding devices, and tools used during the production of titanium tubes by argon-arc and high-frequency welding are noted. The results of investigations of properties of welded titanium tubes and the technical and economic indices of production are given. The prospects for application of the new methods of producing titanium tubes in factories of the USSR are presented. The booklet is intended for engineering and technical workers and skilled workers of plants engaged in the production and application of titanium tubes. The materials presented in the pamphlet can be used by design organizations and by students of technical colleges and technical schools. Author (TAB)

N67-37299# Army Materials Research Agency, Watertown, Mass.
SOLIDIFICATION AND SEGREGATION IN WELDING OF BINARY ALLOYS
Warren C. Malatesta and Donald C. Buffum Jun. 1967 20 p refs
(AMRA-TR-67-19; AD-655262)

The report concerns the initial effort of a long-range program designed to determine the effects that welding variables and base metal chemistry have upon the solidification mode of weld metals. To minimize the complexity of the problem, two relatively pure binary alloys having high solid solubility were selected as parent materials. Weld metals were produced in these parent materials, using a stationary inert-gas shielded tungsten arc and a constant current welding mode. Energy inputs were regulated by controlling arc operation time. Efforts were made to limit heat flow so that experimental procedures would develop constant and reproducible results. Thus far in the program, studies have been limited to metallographic and electron beam microanalysis of the base and weld metal microconstituents. The effects of energy input have been studied and some effects that base metal chemistry has on the growth mode of a solid interface have been observed. Information on the segregation effect in the base metal structures and substructures of the columnar weld metal grains are reported. Photomicrographs showing the growth mode and chemical segregation effect in high and low energy input weld metals are presented. Data developed from the electron beam microprobe analysis are tabulated and correlated with the physical appearance of weld metal growth products. The metallographic study shows that the growth mode of the solid interface at the fusion line is essentially 100 percent epitaxial in nature. Electron beam microprobe analysis shows that chemical micro-segregation in the weld metal growth structures is small, and similar to that in the parent metal. Author (TAB)

N67-37304*# Chrysler Corp., New Orleans, La. Space Div.
ANGLE VALVE, 3/4-INCH, ANNIN COMPANY MODEL NUMBER 3611, NASA DRAWING NUMBER 10428552
15 Apr. 1967 74 p
(NASA-CR-88544; TR-RE-CCSD-FO-1125-3) CSCL 13K

One angle valve specimen used in ground support equipment for Launch Complex 34, was subjected to a series of nine specification tests. The valve contains a 3/4-inch nominal size inlet port with a designed operating pressure of 6000 psig, and is rated for use with nitrogen or helium. During the burst test, the specimen did not attain the 24,000 psig required. Failure of the valve stem packing, packing gland, and bracket occurred at 21,000 psig. Results of the other tests agreed with requirements (receiving inspection, proof pressure, functional, flow, surge, low temperature, high temperature, and cycle). E.C.

N67-37370*# General Electric Co., Cincinnati, Ohio. Flight Propulsion Div.
BEARING FATIGUE INVESTIGATION Final Report
E. N. Bamberger 15 Sep. 1967 203 p refs
(Contract NAS3-7261)
(NASA-CR-72290; R67FPD309) CFSTI: HC $3.00/MF $0.65 CSCL 13I

A research program to establish the feasibility of operating large diameter rolling element bearings at 600F under conditions of load and speed approximating those experienced by main shaft bearings in jet engines is discussed. Two bearing materials and three advanced lubricants were investigated. The lubricants were: synthetic paraffinic oil, polymeric perfluorinated fluid, inhibited, mixed isomeric 5-ring polyphenyl ether 5P4E. Over 54,000 hours of bearing testing were accumulated. Additionally, a large number of bench type rolling contact fatigue tests were conducted, as well as extensive lubricant and metallurgical analysis. The data shows that the paraffinic oil will provide satisfactory hydrodynamic lubrication at 600F in an inerted atmosphere. The polyphenyl ether and the polymeric fluid are marginal in their lubricating capability at the 600F temperature. Bearing failures at 600F are similar to those observed at lower temperatures. Author

N67-37406*# Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR BACK PRESSURE REGULATOR, 21/2-INCH GRAYLOC CONNECTIONS, 6000 PSIG, GROVE VALVE AND REGULATOR COMPANY DRAWING NUMBER M-13636-R, MODEL PB 300 NASA DRAWING NUMBER 10428582
Robert N. Marks 27 Jun. 1967 38 p
(Contract NAS8-4016)
(NASA-CR-88621; TR-RE-CCSD-FO-1109-3) CSCL 13K

The Back Pressure Regulator underwent the following tests: (1) Receiving Inspection, (2) Proof Pressure, (3) Functional, (4) Low Temperature, (5) High Temperature, and (6) Salt Fog. The specimen satisfactorily completed the above tests with the exception of the proof pressure and salt fog tests. During the proof pressure test, the diaphragm relaxed and was replaced. The diaphragm relaxed again during the post salt fog functional test and testing was discontinued. Measurements of the dome retaining boss taken after disassembly of the specimen showed that individual dimensions did not conform to vendor drawings; however, the boss clearance was within specifications. The specimen failed to meet the requirements of the Kennedy Space Center. Author

N67-37407*# SKF Industries, Inc., King of Prussia, Pa. Engineering and Research Center.
EXTREME TEMPERATURE AEROSPACE BEARING-LUBRICATION SYSTEMS Final Report, Nov. 22, 1965–Apr. 30, 1967
L. B. Sibley and L. A. Peacock 20 May 1967 55 p refs
(Contract NAS3-7912)
(NASA-CR-72292; SKF-AL67T063) CSCL 13I

A group of 30 angular-contact 24-mm bore ball bearings made of vacuum-melted high temperature tool steels were life tested successfully at 600°F outer-ring temperature with a synthetic hydrocarbon lubricant having an anti-wear additive. No failures occurred from fatigue spalling of the balls or ring tracks in the 30 bearings tested to a time-up life of 180 hours. Three bearings failed by smearing (gross metal transfer on the balls and grooves due to lubrication-related thermal instabilities) at lives of 18 to 48.9 hours. Another group of 14 bearings were tested in a similar manner except that the test bearings were treated with a black-oxide surface coating known to reduce lubrication-related failures of bearings made of 52100 or M-50 type bearing steels. All of these tests were terminated by smearing or lubrication-related spalling failure at lives of 0.2 to 9.3 hours. Author

N67-37408*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A MECHANICAL TENSION TESTING FACILITY FOR BRITTLE MATERIALS
M. H. Leipold and P. F. Becher 1 Oct. 1967 16 p refs
(Contract NAS7-100)
(NASA-CR-88744; JPL-TR-32-1179) CFSTI: HC $3.00/MF $0.65 CSCL 13H

A mechanical testing facility for measurement of deformation and fracture stresses in tension has been designed, constructed, and evaluated. Special consideration has been given to its use with brittle ceramic materials. The unit makes use of air-floated spherical bearings and close dimensional tolerances along with controlled assembly procedure to reduce axial misalignment. Strains as small as 2×10^{-5} are measured with a pair of commercial optical motion trackers. These trackers avoid introduction of bending moments or mechanical attrition to the specimen surface. Calculation of the magnitude and effect of misalignment are presented. A special streamline contour at the specimen shoulder reduces notch effect. Environmental control permits use of the system in various atmospheres to a maximum temperature of 2500°C. After construction, the capability of the unit has been evaluated to ascertain limits of accuracy. The limits appear to be as follows: (1) Average stress $\leq$1% of full scale (load/unit area), (2) Local stress $\leq$5% of full scale, (3) Strain sensitivity 2×10^{-5}, (4) Strain precision 2% of full scale + 2×10^{-5}, and (5) Meaningful modulii with strains of 2.5×10^{-3} Author

N67-37431# Los Alamos Scientific Lab., N. Mex.
FLAME SPRAYING URANIUM OXIDE
J. J. Rosenthal and M. C. Tinkle 7 Jun. 1967 7 p
(Contract W-7405-ENG-36)
(LA-3677) CFSTI: HC $3.00/MF $0.65

Using specially prepared UO_2 powders, a technique was developed for depositing depleted and enriched UO_2 coatings by flame spraying with an oxyacetylene powder-feed type gun. The coatings were adherent to stainless steel substrates. Chemically, the as-sprayed coatings were little changed from the starting material. Author (NSA)

N67-37445# Los Alamos Scientific Lab., N. Mex.
THREADING AND ASSEMBLY OF SOFT DELTA-STABILIZED PLUTONIUM PARTS
R. R. Gilmore, B. N. Robbins, and J. W. Anderson 16 Jun. 1967 5 p refs
(Contract W-7405-ENG-36)
(LA-3703) CFSTI: HC $3.00/MF $0.65

Delta-stabilized Pu, which is a soft gummy material similar to annealed Cu, is difficult, if not impossible, to thread using conventional taps and dies or thread-cutting techniques. A successful

plunge threading technique and a surface preparation method which permits assembly of threaded delta-stabilized parts without galling are described. Author (NSA)

N67-37471*# International Information, Inc., Philadelphia, Pa.
TRANSFORMATIONS DURING HEATING OF SAP POWDER [PREVRASHCHENIYA PRI NAGREVE PUDRY DLYA SAPA]
A. I. Paisov, A. I. Kolpashikov, L. U. Kotiyeva, Ye. L. Serbinovskaya, and V. A. Shelamov Washington, NASA, Sep. 1967 10 p refs Transl. into ENGLISH from Tr. Mosk. Aviats. Technol. Inst. (Moscow), no. 62, 1965 p 30–37
(Contract NASw-1499)
(NASA-TT-F-10440) CSCL 13H

An investigation was conducted on the variations in the amount and composition of the oxide phase during the sintering of compacted aluminum powder in the manufacture of SAP products. A method for the determination of Al_2O_3 in intermediate SAP products is proposed. Suggestions are given for a sintering process unaffected by unfavorable physicochemical transformations. Author

N67-37487# California Univ., Livermore. Lawrence Radiation Lab.
HYDROGEN ADSORPTION AND CONDENSATION IN A HELIUM CRYOPUMP
Glen L. Wegmann, Angus L. Hunt, and Ronald K. Goodman 10 May 1967 10 p refs
(UCRL-14291) CFSTI: HC $3.00/MF $0.65

Hydrogen pumping speeds were found as a function of the quantity of hydrogen adsorbed or condensed in a helium cryopump. Pumping speed measurements were compared at 2.6 and 4.2°K by evacuation of the helium Dewar to 90 torr. Speeds were obtained for the bare cryopump Dewar and for the Dewar with its surface area increased by a copper felt pad clamped to its bottom. After admission of 0.1 torr-liter of hydrogen at 4.2°K, the copper-felt-covered Dewar had a speed of 320 liters/sec and the bare Dewar 20 liters/sec for an inlet pressure in the 10^{-7} torr range. When the Dewar temperature was reduced to 2.6°K, with the same amount of hydrogen admitted and the same inlet pressure, the speed of the copper-felt-covered Dewar remained the same (320 liters/sec) while the bare Dewar speed increased to greater than 600 liters/sec. These results are explained in terms of a higher surface temperature for the copper-felt-covered Dewar as compared with the bare Dewar. It is experimentally verified that at 2.6°K the equilibrium vapor pressure of condensed hydrogen is sufficiently low that there is no need to rely on adsorption phenomena to provide high hydrogen-pumping speeds. Author (NSA)

N67-37512# Douglas United Nuclear, Inc., Richland, Wash.
BONDING OF ALUMINUM BY THE CAPACITOR DISCHARGE MAGNETIC FORMING PROCESS
Hurshal G. Powers Apr. 1967 13 p ref
(Contract AT(45-1)-1857)
(DUN-1941) CFSTI: HC $3.00/MF $0.65

A procedure is described for bonding caps to Al tubes by a capacitor-discharge magnetic forming-weld. The bonds were He leak tight and of sufficient strength to cause failure of cylinder walls during peel testing. Can wall thickness was reduced less than 10% in the weld zone. Advantages and disadvantages of the method are listed. NSA

N67-37513# Los Alamos Scientific Lab., N. Mex.
PREPARATION OF HIGH DENSITY GRAPHITE BY HYDROSTATIC PRESSING
D. H. Schell and L. A. Wertz 11 May 1967 16 p
(Contract W-7405-ENG-36)
(LA-3864) CFSTI: HC $3.00/MF $0.65

Graphite pieces were made by hydrostatically pressing a thermosetting plastic bonded mix and processing the pressings through a 2500°C graphitizing treatment. Pressings made with 85 parts graphite flour and 15 parts Thermax bonded with Varcum had densities around 1.8 g/cc and compressive strengths around 9000 psi. This investigation included the use of different filler materials, binders, and processing variables in an attempt to optimize density and strength. Author (NSA)

N67-37648*# General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section.
MATERIAL AND PROCESS SPECIFICATIONS FOR REFRACTORY ALLOY AND ALKALI METALS
R. G. Frank, D. N. Miketta, W. H. Kearns, W. R. Young, and R. B. Hand 13 Dec. 1965 434 p refs *Its* Topical Rept.-2
(Contract NAS3-2547)
(NASA-CR-88711; R66SD3007) CSCL 13H

A forced circulation, two phase boiling and condensing potassium loop testing program is being conducted to develop a prototype corrosion test loop for the evaluation of advanced refractory containment and turbine alloys in environments which simulate projected space electric power systems. The prototype corrosion loop consists of a two-loop Cb–1Zr alloy facility; sodium is heated by direct resistance in the primary loop and is used in a heat exchanger to boil potassium in the secondary corrosion test loop. This report covers the preparation of material and process specifications for the procurement, cleaning, and joining of refractory alloys and for the procurement, purification, and handling of the alkali metals to be used in the fabrication and evaluation of the test loops. The major objective in the preparation of the specifications was to assure the utilization of only high quality products with uniform and reproducible properties. Author

N67-37655# California Univ., Livermore. Lawrence Radiation Lab.
HIGH-PRESSURE CONSOLIDATION OF SUBMICRON TUNGSTEN
Gordon E. Zima and John F. Lakner 28 Dec. 1966 28 p refs
(Contract W-7405-ENG-48)
(UCRL-50172) CFSTI: HC $3.00/MF $0.65

The production of ingots of sound macrostructure has enabled a quantitative densification analysis of submicron W using both belt and piston-cylinder high-pressure apparatus. Pressure, temperature, and time ranges are 0.4 to 35 kbar, 600 to 1400°C, 10 sec to 20 min, respectively. Under 23 kbar, 1170°C, and 10 min, sound ingots within 0.4% of theoretical density were obtained. A pressure survey at 1060°C and 10 min revealed a virtual densification equivalence of pressures ranging from 30 to approximately 1.4 kbar, with a sharp break in pressure influence occurring near 1 kbar. A density maximum near 1100°C has been correlated with the onset of grain growth under pressure. Over a mean particle size range of 0.25 to 7.0 μ ingot gas content appears to be the primary determinant of end-point density. Close agreement was obtained with theoretical end-point density predictions based on the plastic flow densification mechanism. Self-diffusion and activation-energy data calculated from 23-kbar processing agreed closely with data obtained from pressureless sintering. Author (NSA)

N67-37689# Los Alamos Scientific Lab., N. Mex.
METALLOGRAPHY OF HYPO-, HYPER-, AND STOICHIOMETRIC SINTERED (U,Pu)C
J. H. Bender [1967] 10 p Presented at 21st AEC Metallographic Group Meeting, Upton, N. Y.
(Contract W-7405-ENG-36)
(LA-DC-8675; CONF-670533-1) CFSTI: HC $3.00/MF $0.65

Procedures for the metallographic preparation of hypo-, hyper-, and stoichiometric sintered $(U_{0.8}Pu_{0.2})C_x$ samples are described. These include cutting, mounting, grinding, and polishing techniques as well as chemical and electrolytic etching for optical and electron microscopy. Author (NSA)

N67-37690# Bettis Atomic Power Lab., West Mifflin, Pa.
PRODUCTION OF THIN-WALLED THORIUM OXIDE CERAMIC BODIES OF HIGH DENSITY BY SLIP CASTING
H. Ullmann, D. Naumann, and W. Burk [1967] 12 p refs Transl. into ENGLISH from Silikat Tech. (E. Berlin), v. 17, 1966 p 209–211
(WAPD-TRANS-61) CFSTI: HC $3.00/MF $0.65

Optimum conditions for preparing ThO_2 ceramic bodies with high sintered density were selected from examples found in the literature, and a suitable slip casting procedure for producing very thin-walled bodies was developed. The basic character of the raw material and thus its proclivity by hydration was considered with special emphasis. NSA

N67-37702# Los Alamos Scientific Lab., N. Mex.
IMPROVED TEE CONNECTIONS FOR VACUUM-JACKETED TRANSFER LINES
Hermann M. Ruess [1966] 12 p ref Presented at the Cryog. Eng. Conf., Palo Alto, Calif.
(Contract W-7405-ENG-36)
(LA-DC-8731; CONF-670801-3) CFSTI: HC $3.00/MF $0.65

A process was developed to form the outer and inner tees in vacuum-jacketed transfer lines at any desired location during assembly. In order to use commercial tee components for the inner jacket, the inner diameter of the outer jacket must be larger than the height of the tee component. Tee connections are made by drawing a die of circular cross section through an elliptical cutout in the wall of the outer jacket. The tee is formed in the inner jacket in the same way, with the inner jacket inside the outer jacket. The shape of the cutout is such that the end of the tee is a flat surface requiring only minor weld preparation. The ends of both tees are fusion welded to extension tubes. The weld geometry simplifies welding procedures, a smooth transition from the main tube to the side tube is produced, and the vacuum space can be reduced to 1/8 in. Fabrication to single-system, mass production, or field applications is economic. Author (NSA)

N67-37703# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
HOT PRESSING OF RARE EARTH OXIDES
H. T. Fullam and C. J. Mitchell Jun. 1967 30 p refs
(Contract AT(45-1)-1830)
(BNWL-448) CFSTI: HC $3.00/MF $0.65

Sesquioxides of Sm and Pm were compacted to densities in excess of 95% of theoretical by pressing at temperatures of 1590°C and pressures of 5100 psi. Under similar conditions Nd_2O_3 and Pm_2O_3 compressed to slightly lower densities. In addition to the normal operating variables that affect hot-press density (time, temperature, and pressure), higher calcination temperatures before pressing lower the density that results for a given set of pressing conditions. For shapes having large length-to-dia ratios, hot pressing gives a uniform density throughout the shape length. Dimensional control is excellent and shape dia can easily be controlled to within 0.001 in. When the pressing characteristics of the oxide are known, shape length can be controlled to within 0.5%. Hot-pressed pellets of the rare earth oxides have excellent physical strength and can be handled readily without physical damage. Nd_2O_3 pellets are sensitive to atmospheric moisture, however, and must be handled accordingly to prevent their disintegration. Sm_2O_3 and Pm_2O_3 pellets, on the other hand, can be left in the open air for many days without suffering any apparent damage. Hot pressing appears to be a most practical method of fabricating Pm_2O_3 into useful shapes. Author (NSA)

N67-37710# California Univ., Livermore. Lawrence Radiation Lab.
DECADE OF ADVANCES IN VACUUM EQUIPMENT AND TECHNOLOGY
T. H. Batzer and R. F. Bunshah 9 Jun. 1967 48 p refs Presented at the Intern. Vacuum Met. Conf., New York, 12–16 Jun. 1967
(Contract W-7405-ENG-48)
(UCRL-70369; CONF-670618-1) CFSTI: HC $3.00/MF $0.65

Improvements in construction and application of vacuum gages, windows, valves, high vacuum pumps, sputter-ion pumps, getter-ion pumps, sublimation pumps, turbomolecular pumps, cryosorption pumps, cryogenic pumps, and vacuum seals are discussed. Illustrations and diagrams are also included. NSA

N67-37718# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
SLIP CASTING OF RARE EARTH OXIDES
H. T. Fullam Jun. 1967 25 p refs
(Contract AT(45-1)-1830)
(BNWL-437) CFSTI: HC $3.00/MF $0.65

The sesquioxides of Sm and Nd can be slip cast (solid casting) in plaster molds very readily. Slip preparation is simple and under optimum conditions the cast shape is easily removed from the mold. Green cast shapes having densities greater than 5 gm/cm^3 were prepared using Sm_2O_3. The only major problem encountered was the tendency of the cast shape of crack on firing. Green shapes of low initial density always cracked or spalled badly on firing. The problem was not as severe with green shapes of high density, and by using very slow heating and cooling rates, it was possible to produce fired shapes that were essentially free of flaws. By firing the green cast shapes at temperatures of 1500°C and higher, it was possible to produce Sm_2O_3 bodies having densities in excess of 7.2 gm/cm^3 (theoretical density is 7.74 gm/cm^3). Very little sintering and compaction occurred when the shapes were fired at temperatures below 1200°C. Green shapes of high initial density showed relatively even shrinkage and little distortion on firing. Low-density green shapes, however, showed very irregular shrinkage on firing in addition to cracking. The over-all potential of slip casting as a method for fabricating promethium sesquioxide into useful shapes depends primarily on the dimensional control required. In those cases where a high degree of dimensional control is required, slip casting does not appear to be practical since dimensional variations of 2 to 3% often result on firing the cast shapes. If some dimensional variations can be accommodated, however, slip casting appears to be a suitable method for producing Pm_2O_3 shapes of moderately high density (90 to 95% of theoretical). Because of radiation exposure problems, any largescale repetitive production operation would have to be carried out in a remotely operated facility. A limited number of casts could be prepared in a gloved box, however, without excessive operator exposure. Author (NSA)

N67-37727# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
VACUUM PUMPING UNIT [VAKUUMNYY OTKACHNOY AGREGAT]
Ye. N. Martinson and B. I. Plechev 27 Feb. 1967 8 p Transl. into ENGLISH from Russian Patent no. 159598 (Appl. no. 807686/24-6, 13 Dec. 1962) 1 p
(FTD-HT-67-19; AD-655353)

The article describes a vacuum - pumping unit which contains a steam ejector and a sorption pump, which for the purpose of decreasing residual pressure and accomplishing a periodical or continuous pumping out of the weakly absorbent inert gases, there are connected up to the pumped - out area in two paralled rows zeolite cooled pumps in sequence with which there is installed a steam and water trap for water vapors. TAB

N67-37764 Laboratorio de Acustica e Sonica, Sao Paulo (Brazil).
ULTRASONIC INSPECTION OF TURBINE MOTOR AXLE AND LARGE BEARINGS [INSPECAO ULTRA-SONICA DE EIXO DE TURBO COMPRESSOR E MANCAIS DO SISTEMO MOTOR]
L. X. Nepomuceno 2 Feb. 1967 10 p In PORTUGUESE; ENGLISH summary
(Rept.-6701.280)

The report describes the method, equipment and accessories, procedures and results of the ultrasonic inspection of a set of bearings, axle and rotor of turbine driven system. The results are presented in schematic drawing form, with photographs of the observed defects and irregularities. Author

N67-37765 Laboratorio de Acustica e Sonica, Sao Paulo (Brazil).
ULTRASONIC INSPECTION OF WELDINGS OF SPECIAL EQUIPMENT [INSPECAO ULTRA-SONICA DA SOLDEGEM DE EQUIPAMENTO ESPECIAL]
L. X. Nepomuceno 30 Jan. 1967 14 p In PORTUGUESE; ENGLISH summary
(Rept.-6701.279)

The report describes the method, equipment and accessories, procedure and the results obtained with ultrasonic inspections of a series of weldments in two special equipment towers. The results are presented in schematic drawings, indicating the observed irregularities with the respective photographs of the echograms. Author

N67-37769 Laboratorio de Acustica e Sonica, Sao Paulo (Brazil).
ULTRASONIC INSPECTION OF WING SPAR ATTACHMENTS JOINTS
L. X. Nepomuceno 27 Jun. 1966 5 p
(Rept.-6606.253)

The report describes the equipment and accessories used in the ultrasonic inspection of wing spar attachment joints and lugs of Viscount aircraft. The results are presented according to PTL-97 issue 7. Author

N67-37770 Laboratorio de Acustica e Sonica, Sao Paulo (Brazil).
ULTRASONIC INSPECTION OF ASTM-A-212-B-FB STEEL PLATES ACCORDING TO ASTM A-435/59T [INSPECAO ULTRA-SONICA DE CHAPAS DE ACO ASTN-A-212-B-FB, SEGUNDO ASTM A-435/59T]
L. X. Nepomuceno 2 Feb. 1967 19 p In PORTUGUESE; ENGLISH summary
(Rept.-6701.291)

The report describes the methods, equipment, accessories, standards and results obtained with ultrasonic inspections of a set of special steel plates. The results are presented in schematic drawings, indicating the observed defects, with photos of the echograms. Author

N67-37776 Laboratorio de Acustica e Sonica, Sao Paulo (Brazil).
ULTRASONIC INSPECTION OF DOWTY-ROTOL PROPELLER CYLINDERS IN PLUNA VISCOUNT AIRCRAFTS [INSPECAO ULTRA-SONICA DOS CILINDROS DAS HELICES DOWTY-ROTOL DOS AVIOES VISCOUNT OPERADOS PELA PLUNA]
L. X. Nepomuceno 26 Jan. 1967 5 p In PORTUGUESE; ENGLISH summary
(Rept.-6701.278)

The report presents the methods, instruments and accessories used in the ultrasonic inspection of a series of propeller cylinders of Viscount aircraft according to Service Bulletin. The results are presented with photographs of the observed echograms. Author

N67-37777 Laboratorio de Acustica e Sonica, Sao Paulo (Brazil).
ULTRASONIC INSPECTION OF SPECIAL STEEL PLATES [INSPECAO ULTRA-SONICA DE CHAPAS DE ACO ESPECIAL]
L. X. Nepomuceno 12 Aug. 1966 38 p In PORTUGUESE; ENGLISH summary
(Rept.-6606.264)

The report describes the ultrasonic method and procedure adopted and the equipment and accessories. The results of the inspection are presented in drawing form, indicating the places where defects were detected, with the corresponding echograms. Author

N67-37799*# Mechanical Technology, Inc., Latham, N. Y.
A SEMI-IMPLICIT NUMERICAL METHOD FOR TREATING THE TIME TRANSIENT GAS LUBRICATION EQUATION
Vittorio Castelli and Charles H. Stevenson Mar. 1967 21 p refs Sponsored in part by NASA and AEC
(Contract Nonr-3730(00))
(NASA-CR-88639; MTI-67TR14) CFSTI: HC $3.00/MF $0.65 CSCL 13I

This report presents a numerical method for treating the time transient Reynolds equation which has the numerical stability properties of implicit schemas and the speed of execution of explicit methods. These advantages make this method quite suitable for both steady-state and transient calculations. Author

N67-37840# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
HIGH-PURITY SHAPE CASTING WITH AN ELECTRON-BEAM FURNACE
C. W. Dean, R. E. McDonald, and C. F. Leitten, Jr. [1967] 15 p Presented at the 9th Ann. Symp. on Electron, Ion, and Laser Beam Technol., New York
(Contract W-7405-ENG-26)
(ORNL-P-3133; CONF-660456-1) CFSTI: HC $3.00/MF $0.65

A description is presented of an electron-beam melting furnace to produce laboratory quantities of high-purity metals using a technique that permits molten charges of high-purity metal to be drop cast into cylindrical or rectangular chill molds. Subsequent fabrication is easier and less expensive because of the improved cast structure and more desirable ingot shapes. In addition, a higher material yield is realized. The drop-casting technique and melting equipment may be used to cast fabricable shapes of Ti, Zr, Nb, V, Ta, W, Mo, and their alloys. Author (NSA)

N67-37843# California Univ., Livermore. Lawrence Radiation Lab.
NEW JOINING TECHNIQUE FOR WATER-COOLED COPPER MAGNET COILS
Jack Gunn and Gerald Fritzke Jun. 1967 5 p Presented at the 2d Intern. Conf. on Magnet Technol., Oxford, 11–14 Jul. 1967
(Contract AT(04-3)-515)
(SLAC-PUB-318; CONF-670705-8) CFSTI: HC $3.00/MF $0.65

The new joining technique, fusing welding of the copper conductor for water-cooled magnet coils, is tested; and a study of

the effects of joint design on the strength and microstructure of a standard hollow square copper conductor is made. The results of tensile tests performed on welded copper are presented. From these tests it is evident that fusion welding with filler-metal additions produces high quality joints in a copper conductor. NSA

N67-37850# Frankford Arsenal, Philadelphia, Pa. Ammunition Development and Engineering Labs.
FEASIBILITY STUDY ON THE FORMING OF DUCTILE IRON Final Engineering Report
Duane O. Gustad Jun. 1967 31 p refs
(Rept.-1002; AD-656457)

The report presents the results of attempts to form cast Ductile Iron into ammunition components by common forming techniques. The forming techniques studied were hot forging, drawing and nosing. Author (TAB)

N67-37860# Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center.
LIQUID METAL ENGINEERING CENTER (LMEC) Quarterly Technical Progress Report, Jan.–Mar. 1967
5 May 1967 60 p
(Contract AT(04-3)-700)
(NAA-SR-12416) CFSTI: HC $3.00/MF $0.65

A review of the objectives and accompliahments of the Liquid Metal Engineering Center during the period January to March 1967 is presented. Progress is reported on the Liquid Metal Fast Breeder Reactor (LMFBR) coolant system valves, piping, and pumps; testing of intermediate heat exchangers and prototype steam generators for the Sodium Component Test Installation; evaluation of information on sodium and NaK alloys as heat transfer and transport fluids; conceptual designs of the Sodium Pump Test Facility (SPTF); testing of sodium pump bearings and seals; design fuel handling devices, control rod drives, and fuel hold-down mechanisms for the sodium-cooled fast breeder reactors; installation of the B & W steam generator in the SCTI; maintenance procedures for temporarily idle LMEC equipment; and the development of high temperature strain measurement gages. NSA

N67-37877# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
WELDING OF NONFERROUS METALS AND THEIR ALLOYS
Ya. L. Klyachkin 24 Apr. 1967 58 p Transl. into ENGLISH from Svarka Tsetnykh Metallov i ikh Splavov (Moscow), 1964 p 284–325
(FTD-MT-65-272; TT-67-62352; AD-655361)

The book considers the theory of welding nonferrous metals, the basic engineering processes (including light refractory metals), the welding regimes, the composition of fluxes, coatings, and filler wire. There is a brief description of special equipment for welding nonferrous metals. Data are included on the corrosion resistance and mechanical strength of weldments. TAB

N67-37904# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
ELECTROSPRAYING DEVICE FOR PRODUCING THIN, UNIFORM SOURCES FROM ROD DISSOLVER AND FINAL PRODUCT PLUTONIUM SOLUTIONS
S. A. Lindsay Apr. 1967 16 p refs
(AECL-2666) Available from Atomic Energy of Canada, Ltd., Chalk River $0.50

Alpha sources, deposited as thin uniform films, can be produced by the ejection of a solution containing the active material from a modified hypodermic needle, while applying an electric field. An apparatus for carrying out the process is described and the results obtained with several different solvents are given. Author (NSA)

N67-37919* Aircraft Armaments, Inc., Cockeysville, Md.
CUTTING TOOL FOR USE IN SPACE Final Report
Jul. 1967 47 p
(Contract NAS8-20680)
(NASA-CR-88860; ER-4978) CSCL 13I

A narrative account is presented on the development of an explosive cutting tool designed to obtain a constantly smooth damage-free cut, and to collect the chips resulting from this cut. The problems involved in, and the solutions to, the fabrication and testing of the feed mechanism, power supply and controls, pneumatic staple, chip collector, and support structure are described. Test data evaluation shows: (1) The pressurized sphere–air motor power supply system provides the required power. (2) The multitooth cutter design assures that a proper combination of speed, feed, and torque, and produces an acceptable cutting action. (3) The pneumatic staple assures the retention of the cut out portion of the skin as shown by the test hardware. (4) The centrifuge chip collecting concept operates satisfactorily under ambient conditions. M.G.J.

N67-37945# Bettis Atomic Power Lab., Pittsburgh, Pa.
PROCEDURE FOR THE FATIGUE EVALUATION OF DEFECTIVE PIPE BUTT WELDS
E. J. McGowan and A. L. Snow May 1967 33 p refs
(Contracts NObs-90029; AT(11-1)-GEN-14)
(WAPD-TM-560) CFSTI: HC $3.00/MF $0.65

An evaluation procedure for determining the acceptability of a weld joint containing defects and subjected to cyclic loading is presented. A method of classifying different types of defects is given and the δ concept of notched fatigue damage is used to assign fatigue strength reduction factors to the different types of defects. The calculation of peak stresses is discussed and determination of stress differences for fatigue evaluation is outlined. Form sheets are included to facilitate the efforts required by the procedure. Author (NSA)

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N67-36763# Air Force Cambridge Research Labs., Bedford, Mass. Optical Physics Lab.
A BIBLIOGRAPHY OF LASER APPLICATIONS
C. Martin Stickley and Arthur Gingrande Apr. 1967 46 p refs *Its* Spec. Rept.-62
(AFCRL-67-0223; AD-655774)

The bibliography of laser applications contains 644 entries from the open literature for the period 1961 through September 1966. The entries are divided into the following major areas: mechanical measurements and standards; communications applications; radar and tracking applications; military applications; optical signal processing; interferometry and testing of optical components; applications to scientific studies; applications in chemistry; photographic applications; metalworking; and miscellaneous applications. The entries are further subdivided into 78 other categories. Applications in medical and biological research are not included; complete coverage in the other areas is not

guaranteed. Under some topics (detection techniques, spectroscopy, interaction with acoustic waves, plasma diagnostics, nonlinear optics, gas breakdown, scattering, holography) so much has been published that only review articles, articles of major importance, and very recent articles could be included. Author (TAB)

N67-36773*# Stanford Univ., Calif. Microwave Lab.
INVESTIGATION OF COHERENT SOURCES OF INFRARED RADIATION Semiannual Status Report, Nov. 1, 1966–Apr. 30, 1967
A. L. Schawlow, Jul. 1967 6 p refs
(Grant NGR-05-020-166)
(NASA-CR-88492; ML-1565; SASR-2) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Cyanide lasers were investigated and found to be unsuitable for magnetic tuning. Preliminary studies of the pulsed laser anomalies are reported, including plasma refraction and absorption, plasma density, and an apparent small splitting of laser frequency. N.E.N.

N67-36842*# Linde Div., Union Carbide Corp., Indianapolis, Ind.
DEVELOPMENT, FABRICATION, AND DELIVERY OF NEODYMIUM DOPED YAG LASER RODS Final Report, Mar. 19, 1965–Mar. 19, 1966
Howard M. Dess 19 Mar. 1966 45 p refs
(Contract NAS8-11865)
(NASA-CR-88510) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The melt pulling technique was scaled up and improved to permit the routine growth of high quality Nd:YAG crystals up to 0.65–0.75 inch in diameter by 3–3.5 inches long. Even in the largest of these specimens, the central core region can be maintained straight and narrow to permit fabrication of core-free 1/4-inch diameter laser rods. Annealing tests at 1850°–1870°C (approximately 100°C below the melting point of YAG) failed to eliminate the core. Similar tests on core-free Nd:YAG also failed to improve the quality as measured by passive optical tests. Fabricated were Nd:YAG laser rods with dielectric end coatings. These rods ranged from 3 mm to 6.38 mm in diameter and 30 mm to 75 mm in length. The rods cut from the largest diameter boules generally showed the best passive optical properties. This is attributed primarily to the more favorable growth conditions existing in the larger stations. The laser thresholds measured were greatly affected by the type of end configuration applied to the rod. No obvious correlation was found between the threshold values and the passive optical measurements recorded for the same rods. Author

N67-37293# Technical Operations Research, Burlington, Mass.
LASER FOG DISDROMETER SYSTEM Final Report, 16 Sep. 1963–30 Apr. 1967
John Ward 30 Jun. 1967 68 p refs
(Contract AF 19(628)-3813)
(TO-B-67-32; AFCRL-67-0399; AD-656487)

Instrumentation to record and size naturally occurring fog droplets in the 5 microns to 100 microns diameter size range has been constructed and used in the field. The system is based on a two-step imaging technique using Fraunhofer holograms. A Q-switched ruby laser illuminates the sample volume and forms the holograms on aerial film. The short time pulse of the laser stops the motion of the droplets and provides instantaneous sampling periodically over the history of a fog. The Fraunhofer hologram technique allows both sufficient resolution as well as considerable depth of field to record the data. A readout instrument was also fabricated; this instrument counts and sizes the fog data by reconstructing, from the hologram frames recorded in the field, real images of the sample volume. Author (TAB)

N67-37699*# National Aeronautics and Space Administration, Washington, D. C.
LASERS AND MASERS: A CONTINUING BIBLIOGRAPHY WITH INDEXES
Jul. 1967 447 p refs
(NASA-SP-7009(02)) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Abstracts and subject and author indexes are presented for research and development documents dealing with lasers and masers; with special emphasis on applications related to ranging and communication systems, astronomy and optics, and metal working. References are also included for fundamental studies dealing with the physical and electronic properties of lasers and masers and their function and performance. All of the references were previously announced in the NASA Scientific and Technical Aerospace Reports (STAR), International Aerospace Abstracts (IAA), or the NASA continuing bibliography on Aerospace Medicine and Biology; and the majority of the articles are arranged according to accession numbers in the first two of these sources. Both 1966 and 1967 entries are included for these as well as for a small group of LC entries from other journals. M.W.R.

N67-37856# Electro-Optical Systems, Inc., Pasadena, Calif.
STUDY OF CROSS RELAXATION AND GLASS LASER AMPLIFIERS Final Report, 1 Nov. 1965–31 Jul. 1967
George L. Clark 31 Jul. 1967 41 p refs
(Contract N00014-66-C-0021; ARPA Order NRO15-627/9-7-65; Proj. Defender)
(EOS-7020-Final; AD-656763)

Spectral hole burning and cross-relaxation in neodymium-doped glass were investigated to determine whether stored energy can be removed rapidly by a spectrally narrow driving signal. By measuring the fluorescence from a pumped sample of glass before and after the passage of the signal pulse as a function of signal energy, quantitative estimates of cross-relaxation time and cross section for stimulated emission are made. Author (TAB)

N67-37903*# Autonetics, Anaheim, Calif.
OPTICAL BEAM STEERING DEVICE Final Report
18 Jan. 1967 25 p
(Contract NAS5-9888)
(NASA-CR-88869; C6-3203/401) CFSTI: HC $3.00/MF $0.65 CSCL 20E

This report describes an optical beam steering device (OBS). The device is intended to be used in conjunction with lasers as a means of changing the direction of the laser beam in a controlled manner by an electrical command signal. The concept employed for the OBS is based upon the use of piezoelectric bender bimorphs as the active deflection elements. Essentially all of the critical design requirements are met by the device. Author

N67-37921# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
EXACT VELOCITY MEASUREMENT BY MEANS OF A LASER INTERFEROMETER [MESURE PRECISE DES VITESSES AU MOYEN D'UN INTERFEROMETRE A LASER]
J. P. Taran 1967 10 p refs In FRENCH Presented at the Mesucora Congr., Paris, 17–21 Apr. 1967
(ONERA-TP-450/1967)

Experimental studies are detailed of velocity measurements by means of a laser interferometer. These highly coherent light sources are utilized in precision trajectography of moving objects. R.Li.

N67-38030*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
SENSING OF METEOROLOGICAL VARIABLES BY LASER PROBE TECHNIQUES Semiannual Report, Feb. 1–Jul. 31, 1967
Giorgio Fiocco 30 Aug. 1967 13 p
(Grant NGR-22-009-131)
(NASA-CR-88872) CFSTI: HC$3.00/MF$0.65 CSCL 20E

Laboratory experiments were conducted to determine the aerosol content of air from the spectral analysis of laser echoes. The laser beam was passed through an aperture to limit the amount of fluorescence radiation emitted, and then passed through a synchronized attenuator. The collected light was collimated and passed through a pressure-scanned Fabry–Perot interferometer. Measurements were made on the spectrum of light scattered from air in the laboratory containing natural aerosol particles, and on air containing an artificially produced dense fog. The analysis indicates that the dust-to-air ratio was approximately one. In another experiment, measurements were made of the density and temperature of the electrons in a low-density reflex discharge by scattering of continuous wave Ar^+ laser light. The data obtained were considered to be in good agreement with probe measurements. M.G.J.

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N67-36741# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
DIFFUSION OF CARBON IN TANTALUM CARBIDES
W. F. Brizes Mar. 1967 11 p refs
(Contract SNP-1)
(WANL-TNR-205) CFSTI: HC$3.00/MF$0.65

The chemical diffusivity of C in TaC and Ta_2C was investigated as a function of temperature from 2100 to 2650°C. The diffusivities determined were found to be in good agreement with the results of others. Experimental evidence is presented however, indicating that the diffusivity of C in TaC is not constant across the stoichiometric range of TaC and may vary by an order of magnitude or more. NSA

N67-36745# Case Inst. of Tech., Cleveland, Ohio. Dept. of Metallurgy.
EFFECT OF MOLD-STEEL INTERFACE REACTIONS ON CASTING SURFACE AND PROPERTIES Final Report, Jul. 1, 1965–Sep. 30, 1966
Rodney L. Naro and John F. Wallace Watertown, Mass., Army Mater. Res. Agency, 24 May 1967 73 p refs
(Contract DA-33-019-AMC-270(Z))
(AMRA-CR-64-03/3; AD-656475)

The research investigated the effect of mold coatings and refractories on the surface quality of cast steel. The influence of surface roughness in reversed bending fatigue was also examined using as-cast specimens of AISI 4330 steel produced in green sand molds coated with hexachlorobenzene, aluminum powder, sodium floroaluminate, and a proprietary mold wash. Plate bending specimens were also produced in uncoated silica, chromite and zircon sand molds and subsequently tested. Test specimens made in both hexachlorobenzene coated silica sand molds and zircon sand produced equivalent results in improving the surface finish of experimental test castings. Bending fatigue test results showed that hexachlorobenzene coated and uncoated zircon provided the greatest overall improvement in fatigue life and endurance limit. The fatigue failures were initiated at cope surfaces with greater frequency than drag surfaces. Author (TAB)

N67-36750# Aktiebolaget Atomenergi, Stockholm (Sweden).
IRRADIATION EFFECTS IN FORTIWELD STEEL CONTAINING DIFFERENT BORON ISOTOPES
M. Grounes Jul. 1967 22 p refs
(AE-288)

Tensile specimens and miniature impact specimens of the low-alloyed pressure vessel steel Fortiweld have been irradiated at 265°C in R2 to two neutron doses, 6.5×10^{18} n/cm^2 (>1 MeV) and 4×10^{19} n/cm^2 (thermal) and also 9.0×10^{18} n/cm^2 (>1 MeV) and 6×10^{19} n/cm^2 (thermal). Material from three laboratory melts, in which the boron consisted of B^{10}, B^{11} and natural boron respectively, were investigated. The results both of tensile tests and impact tests with miniature impact specimens show that the B^{10}-alloyed material was changed more and the B^{11}-alloyed material was changed less than the material containing natural boron. At the higher neutron dose the increase in yield strength (0.2% offset yield strength) was 11 kg/mm^2 in the B^{10}-containing material compared to 5 kg/mm^2 in the B^{11}-containing material. The decrease in total elongation was 5 and 0 percentage units respectively. The transition temperature was increased 190°C at the higher neutron dose in the B^{10}-alloyed material, 40°C in the B^{11}-alloyed material and 80°C in the material containing natural boron. Author

N67-36793* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
REFRACTORY METAL FIBER NICKEL ALLOY COMPOSITES FOR USE AT HIGH TEMPERATURES
Donald W. Petrasek, Robert A. Signorelli, and John W. Weeton Washington, NASA, 1967 51 p refs Presented at the 12th Natl. Symp. of the Soc. of Aerospace Mater. and Process Engr., Orange County, Calif., 10–12 Oct. 1967
(NASA-TM-X-52342) CSCL 11F

Evaluated were the stress-rupture properties of composites containing various combinations of refractory metal fibers and nickel base alloys at 2000°F and 2200°F. The effects of wire size, volume fraction fiber content, and composition of the matrix and the fiber on the stress-rupture properties of the composite were determined. Composites were produced having stress-rupture properties superior to conventional superalloys at these temperatures. The 100 hour creep-rupture strength obtained for the best composites was 35,000 psi and 14,000 psi respectively. Composite strength was related to the compatibility of the fibers with the matrix materials. Stronger composites were produced with matrix materials which reacted less with the fibers than those which were less compatible with the fibers. Fiber diameter was found to be important to the design of composites in which reaction between the fiber and matrix material occurs. A graphical technique was used to illustrate schematically the variation of composite strength as a function of wire size and depth of reaction of the wire with the matrix. Author

N67-36862# Melpar, Inc., Falls Church, Va. Materials Lab.
RESEARCH ON WHISKER-REINFORCED METAL COMPOSITES Final Report, Apr. 1966–Apr. 1967
P. J. Lare, A. P. Divecha, and H. Hahn Washington, D. C., Naval Air Systems Command, May 1967 91 p refs
(Contract NOw-66-0213-d)
(Rept.-6142.00100; AD-655311)

Several aluminum-alloy-sapphire-whisker composite systems were investigated. Consolidation by liquid-phase hot pressing developed previously was significantly improved to yield dense composites with aluminum-silicon hypoeutectic matrices. Strengths in excess of 49,000 psi were obtained in biaxially oriented, unworked composites with 20 to 25 v/o (1-3 micron) whiskers. In general, the percent increase in composite strengths was greater at elevated temperatures than at room temperature. Magnetic alignment of nickel-coated (1-30 micron) whiskers resulted in increasing the uniformity of composite properties. Mechanical working of biaxially oriented aluminum-silicon composites was examined. Hot rolling was the only technique found suitable. Reinforcement in worked composites was erratic owing to severe whisker segregation. Sequential deposition of nickel and chromium by vapor plating was developed and optimized. Fabrication of nichrome composites by densification of the coated whisker mats appeared to be promising. However, initial attempts were hampered by incompatibility of available die materials. Author (TAB)

N67-36955# Institut za Nuklearne Nauke (Boris Kidric), Belgrade (Yugoslavia).

RADIATION DAMAGE IN STEEL WITH MEDIUM AND HIGH CARBON CONTENT

Slobodanka R. Veljkovic, Aleksa Scepanovic, and Vladeta Stefanovic *In its* Bull. of the Boris Kidric Inst. of Nucl. Sci., Vol. 17, No. 2 1966 p 77–88 refs (See N67-36954 22-34)

The radiation damage in iron and some steels with a medium or high carbon content was studied. The fast neutron integral flux was 2.5×10^{19}n/cm^2, and the temperature of the irradiation site was 70±5°C. The damage was measured by changes of the electrical resistivity of samples. The results indicate that a carbon content in the concentration range 0.01%, 0.62–0.93% C had no great effect on the increase of resistivity caused by the irradiation. However, there were big variations with structure. Samples annealed at 630°C before irradiation showed the biggest increase of resistivity after the irradiation. It was twice as big as the increase in samples in as delivered state–bainite quenched. Annealed and cold-worked samples also differed in the extent of the radiation damage. The interaction of already present and induced defects appeared to be considerable. Interaction of the carbon with defects also assumed probably occurred. Author

N67-36976# Battelle Memorial Inst., Columbus, Ohio.

SURVEY OF DEFORMATION PROCESSES AND DEFORMATION CHARACTERISTICS OF DIFFICULT TO FORM METALS Final Technical Report, 10 Feb. 1966–10 Jun. 1967

F. W. Boulger, A. F. Gerds, R. L. Jentgen, G. E. Meyer, H. Ll. D. Pugh et al 10 Jun. 1967 331 p refs
(Contract NOw-66-0214-c)
(AD-655623)

The report covers the following subjects: ductile fracture; application of high pressure to the forming of brittle metals; superplasticity; lubrication in metal-deformation processes; swaging; adiabatic conditions in deformation processing; residual stresses produced by deformation. TAB

N67-37015# United Kingdom Atomic Energy Authority, Windscale (England). Production Group.

ANALYTICAL METHOD FOR THE DETERMINATION OF COBALT IN 0.2% ALUMINIUM ALLOY (E.D.T.A. TITRATION)

C. R. Johnson and H. Mellor 1967 11 p
(PG-789(W)) HMSO: 2s 6d

The sample of aluminium foil, containing 30–100 μg of cobalt, is dissolved in concentrated hydrochloric acid and transferred to an anion exchange column. Aluminium is eluted with concentrated hydrochloric acid, then the cobalt is eluted with water. The pH of the eluate is adjusted to 5 and copper–EDTA complex solution is added, followed by PAN indicator. An equal volume of acetone is added and the cobalt is titrated using 0.002M EDTA. The end point is determined photometrically and the titre obtained graphically. Author

N67-37024*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

THERMO-DIFFUSION IN THE TUNGSTEN–BERYLLIUM SYSTEM

R. M. Arzhanyi, R. M. Volkova, and D. A. Prokoshkin Redstone Arsenal Ala., Redstone Scien. Inform. Center, 21 Jul. 1967 10 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Met. i. Toplivo (USSR), no. 6, 1966 p 162–166 Prepared Jointly with Army Missile Command
(NASA-TM-X-60336; RSIC-688) CSCL 11F

An investigation was conducted on the surface alloying of tungsten by various elements separately and in combinations. It was found that beryllium and tungsten diffusion at 1000°–1200°C proceeds with a front with a simultaneous formation of a number of intermetallic phases of various thickness. The phases are separated between themselves while their boundaries correspond to steps in the concentration curve. The temperature dependences of the diffusion coefficients have been obtained for each phase. By means of X-ray and X-ray spectral analysis the structure and the phase composition of the diffusion layer have been studied. Beryllides of tungsten of the following stochiometric composition have been established: WBe_{24}, WBe_{12}, and WBe_2. The crystal structures of these phases have also been established. Author

N67-37073*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EFFECT OF DUCTILE CLADDING ON THE BEND TRANSITION TEMPERATURE OF WROUGHT TUNGSTEN

Gordon K. Watson Washington, NASA, Oct. 1967 22 p refs
(NASA-TN-D-4184) CFSTI: HC$3.00/MF$0.65 CSCL 11F

A ductile cladding was applied to tungsten in order to determine if such a ductile surface layer would lower the ductile–brittle transition temperature of tungsten. Copper was selected for the cladding and was applied by hot roll bonding at 1040°C. The bend transition temperatures were determined for 0.020-inch- (0.051-cm) thick tungsten sheet clad with 0.00025- to 0.020-inch- (0.0006- to 0.051-cm) thick copper. A decrease in the ductile–brittle bend transition temperature was observed for the clad tungsten in both the longitudinal and transverse directions. Intermediate cladding thicknesses (0.001 to 0.005 in. (0.0025 to 0.013 cm)) yielded the largest decreases. The reduction in transition temperature is thought to be caused primarily by compressive stresses generated in the tungsten during cooling from the roll-bonding temperature. These stresses are the result of the differential thermal contraction of the tungsten and the copper. The cladding also appeared to have slightly improved the ductility of the tungsten, particularly in the transverse direction, by minimizing the effect of surface imperfections. Author

N67-37112# Rocky Flats Div., Dow Chemical Co., Golden, Colo.

TENSILE PROPERTIES OF GAMMA QUENCHED AND AGED URANIUM-RICH NIOBIUM ALLOYS

Ross J. Jackson, Ronald P. Brugger, and Delmar V. Miley 2 Jun. 1967 15 p refs
(Contract AT(29-1)-1106)
(RFP-933) CFSTI: HC$3.00/MF$0.65

Tensile-test data are presented for U-rich Nb alloys containing 11, 15, 17, and 19 at. % Nb in both the solution-quenched and the aged conditions. The tensile-test data are correlated with concurrent metallographic and X-ray studies. The results show that

a wide variety of mechanical properties are available from these heat-treatable, corrosion-resistant, high-density alloys.
Author (NSA)

N67-37121# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE PHYSICAL METALLURGY OF TITANIUM
I. I. Kornilov, ed. 30 Dec. 1966 670 p refs Transl. into ENGLISH of the book "Metallovedeniye Titana. Trudy Pyatogo Soveshchaniya Po Metallurgii, Metallovedeniyu i Primeneniyu Titana i Ego Splavov" Moscow, Izd. Nauka, 1964 p 1–317 Conf. held in Moscow, Mar. 1963
(FTD-HT-66-354; TT-67-62286; AD-655033)

Papers on the metal chemistry of titanium alloys, reaction of titanium with gases, and corrosion, mechanical and technological properties of titanium alloys are presented. For individual titles see N67-37122–N67-37167.

N67-37122# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PROSPECTS FOR THE DEVELOPMENT OF RESEARCH ON THE HEAT RESISTANCE OF TITANIUM ALLOYS [PERSPEKTIVY RAZVITIYA ISSLEDOVANIY ZHARO-PROCHNOSTI TITANOVYKH SPLAVOV]
I. I. Kornilov *In its* Phys. Met. of Titanium 30 Dec. 1966 p 3–17 refs (See N67-37121 22-17)

A careful review of the literature and the correlation of graphs showing heat resistance as a function of composition for certain simple and multicomponent titanium systems have permitted the author to predict the composition of new titanium alloys with optimal heat-resistant characteristics. An important role in the formation of these alloys was played by the stable structure of α- and β-solid solutions, the metallic compounds of titanium, and the alloys based on these metallides. Outstanding among these was the multicomponent α- and β-solid solution based on titanium and its aluminum compounds, Ti_3Al and Ti_3Al, which were formed in the α-solid solution of the Ti–*Al* system. Alloys correctly formed from this system can have a working temperature as high as 600–800C.
Author

N67-37123# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PHASE DIAGRAM OF THE Ti–O_2 SYSTEM AND CERTAIN PROPERTIES OF ALLOYS OF THIS SYSTEM [DIAGRAMMA SOSTOYANIYA SISTEMY Ti–O_2 NEKOTORYYE SVOYSTVA SPLAVOV ETOY SISTEMY]
I. I. Kornilov and V. V. Glazova *In its* Phys. Met. of Titanium 30 Dec. 1966 p 18–37 refs (See N67-37121 22-17)

Microscopic and X-ray analyses and analyses of the changes in the microscopic hardness, the electrical resistance, and the thermoelectromotive forces were carried out on alloys of the Ti–O_2 system, which were quenched after being raised to various temperatures at concentration intervals of from 0 to 35 at. % O_2. From the results of these experiments and the curves of the graphs showing properties of the alloy as a function of composition, the authors were able to pinpoint anomalies in the Hall effect and postulate the existence of two new compounds, i.e.: Ti_6O and Ti_3O. They thus added new equilibrium curves to the graphs of the Ti–O_2 system. Ti_6O is stable up to about 820–830°C, and Ti_3O is probably stable above 1400°C. Tests over a wide range of temperatures and concentrations established the dependence of the coefficient of thermal expansion on the composition of the alloys in this system.
Author

N67-37124# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EQUILIBRIUM DIAGRAM OF THE Ti–Al–Mo–V SYSTEM [DIAGRAMMA RAVNOVESIYA CHETVERNOY SISTEMY Ti–Al–Mo–V]
Ye. N. Pylayeva and Ho Chi Min *In its* Phys. Met. of Titanium 30 Dec. 1966 p 38–44 refs (See N67-37121 22-17)

Research into the phase equilibria of alloys of the quaternary Ti–Al–Mo–V system was undertaken as the basis for strong, heat-resistant alloys with a low specific gravity. The authors chose the quaternary system Ti–*Al*–(Mo: V–1:1). A logical study of these graphs leads to the conclusion that there would be a solid solution based on α-Ti with dense hexagonal substructure, one based on β–Ti with space-centered cubes, a limited γ-solid solution, based on the compound TiAl, with face-centered tetragonal substructure, biphasic $\alpha+\beta$, $\alpha+\gamma$, and $\alpha+\gamma$ zones and a triphasic $\alpha+\beta+\gamma$ zone. Combining these deductions with ternary graphs and the Ti–Al–(Mo:V=1:1) quaternary graph, and projecting the observed trends in phase boundaries, a new representation of the three-dimensional graph of the quaternary Ti–Al–Mo–V system was produced.
Author

N67-37125# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PHASE STRUCTURE OF ALLOYS IN THE Ti–Al–Fe–Cr–Si SYSTEM WITH A CONSTANT ALUMINUM CONTENT [FAZOVOYE STROYENIYE SPLAVOV SISTEMY Ti–*Al*–Fe–Cr–Si S POSOTYANNYM SODERZHANIYEM ALYUMINIYA I KREMNIYA]
V. S. Mikheyev and K. P. Myasnikova *In its* Phys. Met. of Titanium 30 Dec. 1966 p 45–59 refs (See N67-37121 22-17)

The series of strong alloys formed by chromium, iron, silicon, and boron on a titanium–aluminum base has been well studied. The present work continues the experiments of Kornilov on the tetrahedral Ti (0.3% Si)-Al–Fe–Cr system, but with the amount of aluminum held constant at 7.5% by weight and varying the amounts of iron and chromium from 3:1 to 1:1 and 1:3, while keeping their total weight between 0.2 and 30%. Materials used for the experiment were sponge titanium, electrolytic chromium, silicon, aluminum, and iron with carbon, manganese, phosphorus, and sulfur impurities. The samples were heated to temperatures of 1100°, 1000°, 800°, and 500°C and held there for 10, 15, 300, and 750 hours, respectively. Their hardness was measured by Vickers' Method, and their electrical resistance was determined by means of a potentiometer.
Author

N67-37126# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STUDY OF ALLOYS IN THE Ti–Al–Zr TERNARY SYSTEM [ISSLEDOVANIYE SPALAVOV TROYNOY SISTEMY Ti–Al–Zr]
Ye. N. Pylayeva and M. A. Volkova *In its* Phys. Met. of Titanium 30 Dec. 1966 p 60–67 refs (See N67-37121 22-17)

Ti–Al-Zr samples were heated to temperatures ranging from 1200° to 500°C and held there for periods ranging from 6 to 750 hours, respectively. Microstructural and thermal analyses were performed on each sample. The specific electrical resistance and hardness were determined. The results of tests on samples containing the usual 6:1 ratio of titanium to aluminum and having less than 10% by wt. zirconium, when heated to 500°C, showed that the samples contained a new solid solution of $\alpha+\alpha_2$ form. All alloys of this type undergo polymorphic transformations. The specific electrical resistance and hardness, determined from tests on samples which were quenched from tests on samples which were quenched from temperatures of 1100°, 800°, and 500°C, follow an increasing curve; the hardness reaches a maximum in samples cooled from a composition which produces a β-solid solution.
Author

N67-37127# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

PHASE EQUILIBRIUM OF ALLOYS IN THE Ti_3Al–Zr SECTION OF THE Ti–Al–Zr TERNARY SYSTEM [FAZOVOYE RAVNOVESIYE SPLAVOV RAZREZA Ti_3Al–Zr TROYNOY SISTEMY Ti–Al–Zr]

I. I. Kornilov, T. T. Nartova, and M. M. Savel'yeva *In its* Phys. Met. of Titanium 30 Dec. 1966 p 68–74 refs (See N67-37121 22-17)

The authors studied the phase equilibria and certain other characteristics of the Ti–Al–Zr system, in particular the series of systems running, in composition, from pure Zr to pure Ti_3Al (16% Al by weight). The samples were uniformly heated in water to temperatures ranging from 1200° to 500°C for periods of 6–750 hours, respectively. At the same time, samples were heated in a vacuum. Thermal, microstructural, and X-ray analyses were performed on each sample, and the density, hardness, microhardness, and electrical resistance at room temperature were plotted as functions of composition. The results of the phase equilibrium analysis were plotted as a function of temperature and wt. % Zr. The hardness curve has a maximum somewhere between 60–70% Zr. The electrical resistance exhibited an analogous curve which reached an earlier peak. Density increased linearly, as was to be expected, from about 3.6 g/cc at 0% Zr to about 6.5 g/cc at 100% Zr. Author

N67-37128# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STUDY OF THE PHASE STRUCTURE OF ALLOYS IN THE Ti–Al–Zr SYSTEM ALONG THE Ti_2Al–Zr SECTION [ISSLEDOVANIYE FAZOVOGO STROYENIYA SPLAVOV SISTEMY Ti–Al–Zr PO RAZREZU Ti_2Al–Zr]

I. I. Kornilov and N. G. Boriskina *In its* Phys. Met. of Titanium 30 Dec. 1966 p 75–85 refs (See N67-37121 22-17)

Ternary system samples were heated to 1100°C and held there for 10 hours, after which some were immediately quenched in ice water while others were cooled to lower temperatures and held there for extended period of time before being quenched. Another series of samples was quenched from 800°C and a third from 500°C. After quenching a microstructural analysis was made of each sample. Kurnakov's pyrometer was used for the thermal analysis. The density of the samples and their hardness were also determined. Results show a relationship which is not as close to the Ti–Zr system as Ti_6Al–Zr, but is analogous to them. An increase in the proportion of aluminum should cause the characteristics of the curve to approach the Zr–Al system. Author

N67-37129# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE RELATIONSHIP BETWEEN STRUCTURES WHICH ORIGINATE DURING HARDENING OF TITANIUM ALLOYS AND THE EQUILIBRIUM PHASE DIAGRAMS [O SVYAZI STRUKTUR, VOZNIKAYUSHCHIKH PRI ZAKALKE TITANOVYKH SPLAVOV, S RAVNOVESNYMI DIAGRAMMAMI SOSTOYANIYA]

B. A. Kolachev and V. A. Livano *In its* Phys. Met. of Titanium 30 Dec. 1966 p 86–92 refs (See N67-37121 22-17)

In their consideration of alloys of titanium with a β-stabilizer the authors neglect the formation of eutectoid compounds, since with titanium, they are formed only exceedingly slowly and have a negligible influence on the system after quenching. They also postulate that the concentration of elements in the β-phase is below the critical concentration for each temperature at which a martensite (α') reaction goes to completion. They pick two temperatures, T_1 and T_2: Below T_1 the concentration of the β-stabilizer in the β-phase is above critical and there is no martensitic transformation; above T_2 no β-phase is above critical, there is no martensitic transformation and no β-phase remains. Lastly, two concentrations of β-stabilizer are selected, C_1 and C_2: Below C_1 only the martensitic reaction occurs; above C_2 there is enough β-stabilizer to complete the transformation to the β-phase. Comparison of the suggested metastable diagrams demonstrates a marked degree of agreement with experimentally constructed ones. Author

N67-37130# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STABILITY OF β-ALLOYS OF THE Ti–Mo–Cr–Fe–Al SYSTEM [STABIL'NOST' β-SPLAVOV SISTEMY Ti–Mo–Cr–Fe–Al]

N. V. Ageyev, S. G. Glazunov, L. A. Petrova, G. N. Tarasenko, and L. N. Grankova *In its* Phys. Met. of Titanium 30 Dec. 1966 p 93–117 refs (See N67-37121 22-17)

The authors studied the Ti–Mo–Fe–Cr–Al system, both in its β-phase and with an eye to choosing alloys for more detailed experimentation. The samples chosen for experimentation had molybdenum in concentrations of wt. 2–8%, chromium from 4–9%, iron from 3–8%, titanium from 81–83%, and aluminum constant at 3%. All samples but one were held at 200°C for 100 hours, and that one was held at 200°C for 9 hours. Two samples were also held at 300°C for 100 hours; all the remaining samples disintegrated. In samples containing up to 5% each of iron and chromium, 1 or 2% more than 5% Mo did not significantly increase the stability of the β-alloy, and the delay in the process of disintegration is hardly worth the cost. Author

N67-37131# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

METASTABLE POLYMORPHISM OF ALLOYS WITH A BASE OF ELEMENTS FROM GROUP IV [O METASTABIL'NOM POLIMORFIZME SPLAVOV NO OSNOVE ELEMENTOV CHETVERTOY GRUPPY PERIODI-CHESKOY SISTEMY]

N. F. Lashko *In its* Phys. Met. of Titanium 30 Dec. 1966 p 118–129 refs (See N67-37121 22-17)

Alloys, on being quenched from temperatures in the β-phase region, may undergo several types of metastable polymorphic transformations. It seems that when the temperature of the eutectoid transformation approaches that of the polymorphic transformation $\beta \rightarrow \alpha$ in the pure metal, the conditions favorable to a whole series of metastable transformations are fulfilled. In the present work, 4 Zr–Nb alloys ranging from 6 to 20% Nb were quenched in water from temperatures of 750°–880°C and aged at temperatures of 400°–550°C for periods of 0.5–50 hours. Alloys containing 8% Nb, when quenched from 880°C and studied immediately or when aged at 400° and 430°C for 2 and 0.5 hours, respectively, showed the $\beta \rightarrow \beta + \omega$ reaction, but showed no such reaction when aged at 550°C, thus verifying previous conclusions. Author

N67-37132# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DILATOMETRIC STUDY OF TRANSFORMATIONS IN TITANIUM ALLOYS [DILATOMETRICHESKOYE ISSLEDOVANIYE PREVRASHCHENIY V TITANOVYKH SPLAVAKH]

L. P. Luzhnikov, V. M. Novikova, and A. P. Marsev *In its* Phys. Met. of Titanium 30 Dec. 1966 p 130–144 refs (See N67-37121 22-17)

This is part of an extended study on the reaction of titanium alloys to thermal treatment, including a study of mechanical properties and microstructure. Dilatometric aging and surface hardening studies were conducted on industrial alloys containing additions of 2 to 4 of the elements Al, Cr, Mo, V, Si and Sn in various amounts, as well as on the systems Ti–Cr, Ti–Mo, Ti–Al–Cr and Ti–Al–Mo, containing 3–10% of these additions, at temperatures increasing up to 1000°C by 4.5–5 degrees/min.

Dilatometric curves are presented for the various alloys and related to their microstructures and phases. No dilatometric effect was seen in the industrial alloys upon heading from the quenched state, with the exception of (5% Al, 1.7% Cr, 2% Mo) which showed a negative effect in the 285°–400°C range after quenching from the two-phase range (845°C). The correlation of phase and hardness (Rockwell test) is discussed. In the VT3-1 alloy quenched from 845°C ($\alpha+\beta$), the β-phase containing Cr and Mo is fixated in supercritical concentration. The ω-phase will appear as a result of aging in the 350°–400°C range. The amount of fixed β-phase may apparently reach 30–40%, that of the ω-phase 50%. This explains the considerable effect of aging on properties of the alloy. Author

N67-37133# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DISLOCATION THEORY OF HYDROGEN BRITTLENESS IN TITANIUM ALLOYS [DISLOKATSIONNAYA TEORIYA VODORODNOY KHRUPKOSTI TITANOVYKH SPLAVOV]

B. A. Kolachev, V. A. Livanov, and A. A. Bukhanova *In its* Phys. Met. of Titanium 30 Dec. 1966 p 145–157 refs (See N67-37121 22-17)

The study concerns the reversible brittleness developing in typical $\alpha+\beta$ alloys at low deformation rates. The mathematical basis is given by the Kottrell formula $v_c = 4D/l$ where v_c is the critical velocity at which the atmospheres begin to be carried away by the mobile dislocations, D the diffusion coefficient of the admixture, and l the characteristic length. The critical deformation rate increases with temperature but does not depend on the hydrogen content of the alloy, while the temperature T_D at which plasticity is restored and the related T_D depend on the mean hydrogen concentration. The temperature interval within which hydrogen brittleness can develop is bounded above by the dissociation temperature of the Kottrell atmospheres (T_D) and below by T_H below which the dislocations leave the Kottrell atmospheres. This theory affords explanation of the regularities observed for the above alloys. The regularities to be expected from the dislocation theory agree satisfactorily with experimental data for the alloy Ti140A (0.0375% by weight H_2). Author

N67-37134# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INFLUENCE OF ALLOYING OF THE PHYSICO-MECHANICAL PROPERTIES OF TITANIUM [VLIYANIYE LEGIROVANIYA NA FIZIKO-KHIMICHESKIYE SVOYSTVA TITANA]

S. F. Koftun and R. A. Ul'yanov *In its* Phys. Met. of Titanium 30 Dec. 1966 p 158–181 refs (See N67-37121 22-17)

The influence of the usual additions (Al, Cr, Mo) on electrical resistivity, linear expansion and oxidizability, as well as that of other elements (Re, Ta, Ir, Pd, Be, La) that could improve the physicochemical properties were studied in experimental alloy specimens (preparation described) at temperatures from −195° to 1250°C; various percentages of the additives were tested by compensation and dilatometry. It was found that changes in hardness and resistivity of titanium alloys in the range of solid solutions from −196°C to phase transformation temperatures are determined by the ratio of the atomic diameters and the chemical nature of the additives. Upon continued heating, the temperature coefficient of resistivity remains positive, while decreasing absolutely. Chromium, Ta and La strongly increase the oxidation rate at 800°C; Pd in low concentrations and Re have a favorable influence on the protective properties of the oxide film at this temperature. Author

N67-37135# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DETERMINATION OF THE CHARACTERISTICS OF MUTUAL DIFFUSION OF TITANIUM AND MOLYBDENUM FROM THE ATTENUATION OF γ-IRRADIATION [OPREDELENIYE KHARAKTERISTIK VZAIMNOY DIFFUZII TITANA I MOLEBDENA PO OSLABLENIYU γ-IZLUCHENIYA]

A. Ya. Shinyayev, V. O. Akopyan, L. F. Sokiryanskiy, and I. V. Bogolyubova *In its* Phys. Met. of Titanium 30 Dec. 1966 p 182–192 refs (See N67-37121 22-17)

The interlocking of molybdenum with titanium or its alloys was determined by recording the attenuation of gamma irradiation during passage through various parts of the diffusion zone. Annealed Ti and the Mo specimen were pressed together, followed by annealing at various temperatures (905°–1210°C) for 7–240 hours. From a typical curve of a specimen annealed at 1100°C for 40 hours it may be seen that the irradiation intensity decreased by a factor of 15 during passage. The diffusion constants were calculated by statistical estimation. As the temperature increased from 905° to 1210°C, the coefficient of mutual diffusion (cm^2/sec.) increased from 1.5 to $55+10^{-10}$ in the titanium zone and up to 2.8°C 10^{-9} in the molybdenum zone. Author

N67-37136# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

REDISTRIBUTION OF IMPURITIES IN TITANIUM AND ITS ALLOYS DURING OXIDATION [O PERERASPREDELENII PRIMESEY V TITANE I YEGO SPLAVAKH PRI OKISLENII]

N. V. Korolev, S. A. Gorbunov, A. S. Bogdanov, and G. P. Nadutenko *In its* Phys. Met. of Titanium 30 Dec. 1966 p 193–204 refs (See N67-37121 22-17)

The possible redistribution of impurities between the surface layers and the basic mass of titanium specimens during oxidation in air was studied on pure titanium and some alloys after heating at 800°–1200°C; carbon, nitrogen, iron, aluminum, silicon, calcium and magnesium were determined. Spectral analysis and measurements of microhardness showed that the gas-saturated layer in specimens oxidized at 1100°–1200°C is a solid solution which includes not only oxygen, but also carbon (to 1%) and nitrogen (to 3%); besides, some enrichment of the surface layer by iron, silicon and aluminum was observed. Spectral analysis showed enrichment of the gas-saturated layer by alloying elements after oxidation; at certain temperatures, the amount of Mo, V and Cr exceeded the initial content 2–3 fold, and almost pure tin and copper appeared on the surface. Author

N67-37137# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INFLUENCE OF OXYGEN ON THE MECHANICAL PROPERTIES OF THE HEAT-TREATED AT3 AND AT8 ALLOYS (PRELIMINARY COMMUNICATION) [VLIYANIYE KISLORODA NA MEKHANICHESKIYE SVOYSTVA TERMICHESKI OBRABOTANNYKH SPLAVOV AT3 I AT8 (PREDVARIETE'NOYE SOOBSHCHENIYE)]

B. K. Vul'f and S. A. Yudina *In its* Phys. Met. of Titanium 30 Dec. 1966 p 205–212 refs (See N67-37121 22-17)

The present paper considers the effect of oxygen content on the mechanical properties of two type AT alloys, that with the lowest Al content (AT3) and the highest Al content (AT8). The alloy was melted in an arc furnace charged with pure chromium, iron and silicon, while boron was added as a 10% Cr–B alloy. The oxygen was introduced as powered TiO_2. The amount of oxygen introduced was 0.10, 0.13, 0.23, 0.28, 0.33 and 0.43% by weight. Heat treatment consisted of hardening in air from 850°C for AT3 and from 950°C for AT8 during 45 minutes. Tensile strength increased when the oxygen content was changed from 0.10 to 0.43%, while the plasticity and resiliency dropped, prior to heat

treatment. After heat treatment, the results were similar, but less pronounced. The AT8 alloy showed a sharper decrease in plasticity, while the AT3 alloy showed a sharper drop in resiliency. Author

N67-37138# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SPECIFIC FEATURES OF THE OXIDATION OF SOME TITANIUM ALLOYS WHEN HEATED PRIOR TO PLASTIC DEFORMATION [OSBENNOSTI OKISLENIYA NEKOTORYKH TITANOVYKH SPLAVOV PRI NAGREVE PERED PLASTICHESKOY DEFORMATSIYEY]

I. M. Pavlov, A. Ye. Shelest, and Ye. G. Konstantinov *In its* Phys. Met. of Titanium 30 Dec. 1966 p 213–219 refs (See N67-37121 22-17)

The present paper considers the results of a study of the kinetics of oxidation of several Ti alloys under conditions of plastic deformation. The samples (10–16 mm cubes) were placed in porcelain crucibles with access to air ensured from all sides and heated to 800°–1200°C for durations of 15, 30, 60, 120 and 240 minutes. The samples were than weighed both with and without the crucibles and with the scale removed. The change in weight was related to sample area prior to oxidation. The tests showed that the oxidation rate depends on the oxygen concentration gradient in the surface layer of the metal. The value of the oxidation rate was determined by graphic differentiation of the kinctic curves for prolonged oxidation. Generally, the rate changes gradually and reaches a constant, known as the characteristic rate. Author

N67-37139# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

NITRIDING OF TITANIUM ALLOYS AT REDUCED PRESSURES [AZOTIROVANIYE TITANOVYKH SPLAVOV PRI PONIZHENNYKH DAVLENIYAKH]

Ye. N. Novikova *In its* Phys. Met. of Titanium 30 Dec. 1966 p 220–231 refs (See N67-37121 22-17)

The present paper considers the effect of low pressure nitriding on the nitrogen penetration and structure of the diffusion layer. VT1 titanium, alloys VT3-1, VT4 and VT5 and test alloys Ti–Al–Mo, Ti–Al–Sn and Ti–Al–Cu were investigated. Cylindrical samples with a diameter and height of 10 mm were turned from 14 mm bars. Nitriding was performed mostly at 950°C and partially at 870 and at pressures of 760, 100, 1, 10^{-1} and 3×10^{-2} mm Hg. The tests showed that lowering of pressure in the chamber from 760 to 1-0.1 mm Hg during nitriding of Ti alloys leads to a 50–100% increase in the nitrided layar, while the depth of the brittle nitride zone is decreased several times. The layer obtained in a vacuum has high wear resistance which compares with the resistance obtained at normal pressure. The mechanical properties of the core of the VT4 alloy sample after nitriding in a vacuum differ only slightly from the properties obtained at normal pressure. Author

N67-37140# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CORROSION OF TITANIUM AND TITANIUM ALLOYS OF THE VT AND AT SERIES IN SULFURIC ACID SOLUTIONS CONTAINING NICKEL SULFATE [KORROZIYA TITANA I TITANOVYKH SPLAVOV SERIY VT I AT V RASTVORAKH SERNOY KISLOTY, SODERZHASHCHIKH SUL'FAT NIKELYA]

S. A. Nikolayeva and V. A. Zinov'yev *In its* Phys. Met. of Titanium 30 Dec. 1966 p 232–240 refs (See N67-37121 22-17)

The present paper considers the corrosion stability of sheet, bar and forged titanium in sulfuric acid. Bar titanium was found to have the highest resistance. It could be passivated at room temperature even in sulfuric acid with a concentration of 300 grams per liter. In studies on Ti alloys, the corrosion rate was measured by the weight loss of the samples in $g/m^2.hr$. Alloy components such as molybdenum and vanadium aid Ti passivation, but the presence of Al, Pb, Mg and Fe increases the corrosion rate of Ti. Chromium also aids passivation. Small additions of Ni promote corrosion of titanium, while further increases in the nickel concentration lead to a lower corrosion rate. In conclusion, the VT15, VT14, AT_2-1, AT_2-2, and AT_2-3 alloys show high corrosion resistance in strongly acidic solutions of nickel. The tests showed that the sulfate ion aids passivation of these alloys, and that nickel or copper ions generally stimulate corrosion. Author

N67-37141# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CHEMICAL STABILITY OF TITANIUM IN SOME AGGRESSIVE MEDIA AND ITS APPLICATION FOR EQUIPMENT IN THE CHEMICAL INDUSTRY [KHIMICHESKAYA STOYKOST' TITANA V NEKOTORYKH AGRESSIVNYKH SREDAKH I OBLASTI YEGO PRIMENENIYA DLYA APPARATURY KHIMICHESKOY PROMYSHLENNOSTI]

S. M. Babitskaya, V. A. Strunkin, T. D. Zal'tsman, and Yu. I. Sorokin *In its* Phys. Met. of Titanium 30 Dec. 1966 p 241–249 refs (See N67-37121 22-17)

Tests with titanium showed strong corrosion in oxalic acid (100 mm/year, or the same as in 20% hydrochloric acid). Low stability of titanium was also noted in formic acid, tartaric acid and citric acid, as well as in mixtures of glacial acetic acid with acetic anhydride. Strong corrosion of titanium was observed in hot solutions of oxalic acid and tartaric acid, while the highly aggressive properties of citric acid are explained by the solubility of the compounds in water. These results indicate new possibilities for the use of titanium equipment where hydrochloric, hydrobromic, hydriodic and sulfuric acids containing free halogens participate in chemical reactions. Titanium tips are employed on thermocouples working in chlorination processes. Laboratory tests have shown the harmful action of alternating current on titanium in acid solutions, but a titanium bubbler has been working successfully in the production of chlorine. Author

N67-37144# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STUDY OF THE APPLICATION OF TITANIUM ALLOYS IN FOOD MACHINERY [ISSLEDOVANIYE PRIMENENIYA TITANOVYKH SPLAVOV DLYA PISHCHEVOGO MASHINOSTROYENIYA]

F. N. Tavadze and T. A. Lashkhi *In its* Phys. Met. of Titanium 30 Dec. 1966 p 280–294 refs (See N67-37121 22-17)

The present paper continues earlier investigations of the possibility of using titanium alloys of the AT series for food industry machinery. Previous tests showed high corrosion resistance of AT alloys in various media. Tests were therefore made with weld seams of AT3 and AT8 alloys in two solutions: K1 (2% tartaric acid, 2% citric acid, 0.5% malic acid, 2% acetic acid, 2% dextrose, 4% common salt, 3% oxalic acid, 1% lactic acid, total acidity 2.71, pH 0.81, and V1 (3% tartaric acid, 1% citric acid, 1.5% acetic acid, 12% ethyl alcohol, 0.6% methyl alcohol, 0.3% tannin, 1% dextrose, total acidity 1.22, pH 1.80). Simultaneously, *1Kh18N9T stainless steel* and an experimental *chromium-manganese* steel were tested. It is concluded that AT3 and AT8 alloys at room temperature show the highest possible corrosion stability in oleic, oxalic, tartaric, acetic and lactic acids, as well as in K1 and V1 solutions. Author

N67-37145# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

BASIC PREREQUISITES FOR DEVELOPING HIGH-STRENGTH TITANIUM ALLOYS WITH AN $\alpha+\beta$-STRUCTURE BY ALLOYING AND HEAT TREATMENT [OSNOVNYYE PREDPOSYLKI SOZDANIYA VYSOKOPROCHNYKH TITANOVYKH SPLAVOV S $\alpha+\beta$-STRUKTUROY PUTEM LEGIORVANIYA I TERMICHESKOY OBRABOTKI]

V. N. Moiseyev *In its* Phys. Met. of Titanium 30 Dec. 1966 p 295–307 (See N67-37121 22-17)

The paper considers the properties of titanium alloys with an alpha+beta structure in relation to their composition and heat treatment. Titanium alloys containing up to 30% Mo, 20% V, 50% Nb, 50% Ta, 15% Fe, 15% Cr and 20% Mn were tested. The alloys were subjected to double melting in a vacuum arc furnace. The ultimate strength was about 37 kg/mm^2 and the alloy contained 0.05% Fe, 0.03% C, 0.02% Si, 0.011% N_2 and 0.06% O_2 The ingots were forged into bars 12 mm in diameter and then rolled into 1.2 mm sheets, from which samples were cut. The test proved that the difference in strength between nonalloy titanium and α alloys with β elements amounts to 3–13 kg/mm^2. This difference is caused by a finer grain structure as the heterogeneity of the structure increases. Higher strength was also noted in alloys with a higher content of β phase. The author concludes that alloys with a heterogeneous structure having about the same quantities of α and β phases have the highest strength. Author

N67-37146# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STRENGTH OF THE INTERATOMIC BOND IN SINGLE-PHASE ALLOYS IN THE Ti–Nb–Cr SYSTEM [PROCHNOST' MEZHATOMNOY SVYAZI ODNOFAZNYKH SPLAVOV SISTEMY Ti–Nb–Cr]

K. I. Shakhova and I. B. Budberg *In its* Phys. Met. of Titanium 30 Dec. 1966 p 308–317 refs (See N67-37121 22-17)

The present paper investigates the forces of interatomic bonding in monophasic Ti–Nb–Cr alloys. All alloys with 50% Cr, where the γ-phase is predominant, show a modulus of normal elasticity of the solid solution which is much higher than for the pure components of the β-phase. The values of the mean distribution of atoms were calculated by the Debye-Weller equation. The tests showed that niobium has less of an effect on the forces of interatomic bonding than chromium. The tests also indicated that increasing the niobium content in the γ-solid solution leads to proportional increases in the characteristic temperature and bonding strength in the γ-phase lattice. By analyzing the data on the variation in hot strength of the alloys it can be seen that monophasic β-solid solutions are weakened more rapidly than γ-phase alloys. The results also corroborate previous conclusions from the analysis of atomic distribution at 0 and 293K. Author

N67-37147# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STUDY OF CREEP OF ALLOYS IN THE Ti–V–Nb–Mo SYSTEM [ISSLEDOVANIYE POLZUCHESTI SPLAVOV SISTEMY Ti–V–Nb–Mo]

I. I. Kornilov, O. K. Belousov, and V. S. Mikheyev *In its* Phys. Met. of Titanium 30 Dec. 1966 p 318–327 refs (See N67-37121 22-17)

The present paper considers the heat resistance of Ti–V–Nb–Mo alloys at stresses of 15–20 kg/mm^2 and temperatures of 500° and 600°C. The alloy samples were made with V:Nb:Mo = 1:1:1 Mo:sum of V, Nb = 2:1, Nb:sum of V, Mo = 2:1, and V:sum of Nb, Mo = 2:1. Analysis of the relationship between deflection and duration of deformation showed that the alloys behaved differently. Titanium had the highest creep rate, while alloys near the boundary of saturated α_4 solid solutions had the highest strength. The data obtained on the relationship between heat resistance, composition and phase structure indicate that all alloys of the α-phase of the Ti–V–Nb–Mo alloy are rapidly weakened at 500°C and 15 kg/mm^2 and cannot resist heat for a long time under these conditions. Author

N67-37148# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SPECIFIC FEATURES OF THE COLD BRITTLENESS OF TITANIUM [OSOBENNOSTI KHLADNOLOMKOSTI TITANA]

B. B. Chechulin and M.B. Bodunova *In its* Phys. Met. of Titanium 30 Dec. 1966 p 328–341 refs (See N67-37121 22-17)

To determine the effect of *hydrogen* on the NDT(mil ductility temperature) of commercial titanium and the dependence of the NDT on the volume-stressed state (notch sharpness), strain rate, and size factor, smooth and notched specimens of titanium containing 0.002–0.06 wt% H_2 were subjected to tests for static and impact bend, impact toughness, and tension at temperatures ranging from −196°C to 350°C. The tests showed that the impact toughness of both smooth and notched specimens of *vacuum heat-treated* titanium does not decrease with decreasing temperature to −196°C. Increasing the hydrogen content to 0.015 wt% sharply decreased the impact toughness of notched specimens at temperatures below 100°C. With a 0.035 wt% H_2, however, smooth titanium specimens became brittle at 60°C. Addition of hydrogen limits the strength increase to the strength at brittle fracture which is practically independent of temperature. Thus the experimental data obtained show that the cold brittleness of titanium is mainly caused by an abrupt drop in its resistance to rupture resulting from hydrogen contamination. Author

N67-37149# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CREEP OF AT3 ALLOY AT 350° [POLZUCHEST' SPLAVA AT3 PRI TEMPERATURE 350°]

K. P. Markovich, V. S. Mikheyev, and Z. G. Fridman *In its* Phys. Met. of Titanium 30 Dec. 1966 p 342–348 refs (See N67-37121 22-17)

The paper describes studies on the creep limit of the AT3 titanium alloy at 350°C for a total deformation of 1% after 20,000 hours, as well as the changes in mechanical properties after creep testing. The testing was done at a constant temperature of 350°C and stresses of 15, 30, 33, 37, 45 and 50 kg/mm^2 for 5454, 6662, 5705, 5215, 12,000 and 9300 hours. The shape of the curve after creep testing at stresses of 15 and 30 kg/mm^2 approached a straight line. The total deformation after 5000 hours increased with the creep stress from 0.18% at 15 kg/mm^2 to 0.92% at 37 kg/mm^2. For 45 and 50 kg/mm^2 the set creep begins after 400 hours and does not end before 12,000 hours, when the total deformation is 1.2%. The tests showed that the creep rate at a residual deformation of 1% after 20,000 hours is 5×10^{-5}%/hr. Consequently, the limiting stress causing a creep rate of 5×10^{-6}%/hr at 350°C for AT3, containing 2.7% Al and 1.26% Cr, Fe and Si, is 42 kg/mm^2. Author

N67-37150# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STUDY OF THE CREEP AND HEAT STABILITY OF THE AT4 ALLOY AT 500° [ISSLEDOVANIYE POLZUCHESTI I TERMICHESKOY STABIL'NOSTI SPLAVA AT4 PRI 500°]

I. I. Kornilov, O. N. Andreyev, and B. M. Vodshechenko *In its* Phys. Met. of Titanium 30 Dec. 1966 p 349–355 *ref* (See N67-37121 22-17)

Creep behavior and thermal stability of AT4 titanium-base alloy (4.67% Al, 0.86% Cr, 0.31% Fe, 0.27% Si, and 0.001% B) have been investigated at 500°C. In a 1000-hr test under 5

kg/mm^2 stress, total elongation was 0.5%, and under 2.5 kg/mm^2 stress it dropped to 0.18%. The creep rate at the steady stage was $0.3 \cdot 10^{-6}$% per hour under 2.5 kg/mm^2 stress and $1.6 \cdot 10^{-6}$% per hour under 5 kg/mm^2 stress. Thus, AT4 alloy at 500°C has a substantially higher creep resistance than such titanium alloys as OT4, *VT6*, and *OT4-2*; this was also displayed in a 100-hr creep test under a 20 kg/mm^2 stress. The mechanical properties of AT4 alloy remain almost unchanged, and it retains its high ductility after 1000 hr under stress at 500°C. Author

N67-37151# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

EVALUATION OF THE RELAXATION LIFE OF THE AT3 ALLOY [OTSENKA RELAKSATSIONNOY STOYKOSTI SPLAVA AT3]

L. P. Nikitina *In its* Phys. Met. of Titanium 30 Dec. 1966 p 356–365 refs (See N67-37121 22-17)

Tests required to determine the relaxation stability of the AT3 alloy over a wide range of temperatures and stresses showed that when the initial stress becomes higher the relaxation process becomes more intensive. The tests also showed an exponential relationship between the relaxation time and temperature. Analysis of the temperature relationship of the residual stress showed no relationship between the minimum rate and activation energy in either the usual or logarithmic curves. The paper concludes that the AT3 alloy between 350° and 650°C is stable against relaxation up to 400°C. A drop in stress of up to 60–80% of the initial stress during hundreds and thousands of hours is explained not only by the temperature, but by the initial stress. Author

N67-37152# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CREEP OF ALLOYS IN THE QUATERNARY Ti–Zr–Al–Sn SYSTEM AT 750° [POLZUCHEST' SPLAVOV CHETVERNOY SISTEMY Ti–Zr–Al–Sn PRI 750°]

I. I. Kornilov, T. T. Nartova, and M. M. Savel'yeva *In its* Phys. Met. of Titanium 30 Dec. 1966 p 366–373 refs (See N67-37121 22-17)

The present paper investigates the creep of the Ti–Zr–Al–Sn alloys beginning with pure Zr and ending with the quasiternary system Ti_3Al–Zr–Ti_3Sn. The alloys were made in arc furnaces in argon with Ti having an ultimate strength of 38 kg/mm^2, iodide zirconium of 99.9% purity, aluminum and 99.9% pure tin. The alloy was annealed at 850°C for 30 minutes. The creep resistance of Ti–Al–Zr along Ti_3Al–Zr was tested at 750°C and 15 kg/mm^2 for 1000 hours. The creep curves showed that small additions of zirconium (1–5%) to Ti_3Al do not affect the heat resistance of this compound. The deflections were then measured for different alloy compositions, optimal properties being obtained on the basis of a solid solution of Ti_3Al with zirconium and tin. This alloy was further improved in relation to plasticity by addition of vanadium, niobium and molybdenum. On the basis of testing it was found that vanadium, niobium and molybdenum also improved the heat resistance of the solid solution on the basis of Ti_3Al *molybdenum* and *niobium* to a greater extent than *vanadium*. Up to 0.5% V should be added to higher heat resistance. Author

N67-37153# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF THE MECHANICAL PROPERTIES OF AT3, AT4, AT6 AND AT8 TITANIUM ALLOYS AS FUNCTIONS OF TEST TEMPERATURE [ISSLEDOVANIYE MEKHANICHESKIKH SVOYSTV TITANOVYKH SPLAVOV AT3, AT4, AT6, I AT8 V ZAVISIMOSTI OT TEMPERATURY ISPYTANIYA]

V. S. Mikheyev *In its* Phys. Met. of Titanium 30 Dec. 1966 p 374–381 refs (See N67-37121 22-17)

The author investigated the mechanical properties of AT alloys at testing temperatures of 20° to 800°–1000°C. The alloys with optimal properties were unbalanced α-solid solutions with an insignificant quantity of β phase. The ultimate strength of titanium is sharply lowered when the testing temperature is raised to 200°C, as well as between 500° and 800°C, while the changes between 200° and 500°C are insignificant. The introduction of *Al, Cr, Fe, Si* and *B* into titanium alloys increases the ultimate strength in comparison with iodide titanium and lowers the plasticity. The tests showed that increasing the aluminum content in the α-solid solution leads to lower plasticity. The paper concludes that Ti–Al–Cr–Fe–Si–B alloys, types AT3, AT4, AT6 and AT8, have an α-solid solution structure with an insignificant quantity of β phase, with high mechanical properties at both room and high (450°–600°C) temperatures. Increasing the aluminum content to 3–8% leads to an increase in ultimate strength, while the plasticity is lowered. Author

N67-37154# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STUDY OF THE COMPARATIVE HEAT RESISTANCE OF TITANIUM ALLOY SHEETS AND THEIR WELDMENTS AT TEMPERATURES OF 450, 550, 650, AND 700° [ISSLEDOVANIYE SPRAVNITEL'NOY ZHAROPROCHNOSTI LISTOVYKH TITANOVYKH SPLAVOV I IKH SVARNYKH SOYEDINENIY PRI TEMPERATURAKH 450°, 550°, 650°, I 700°]

I. I. Kornilov, O. N. Andreyeva, B. M. Vodshchenko, and V. A. Karmanov *In its* Phys. Met. of Titanium 30 Dec. 1966 p 382–396 refs (See N67-37121 22-17)

Solid and welded 1 mm-thick sheets of *OT4, VT5-1, VT14, T3M, OT4–2, AT3, AT4, AT6*, and *AT8* titanium-base alloys were tested for heat resistance at 450°, 550°, 650° and 700°C by the centrifugal method. It was found that the heat resistance of AT3, AT4, AT6, and AT8 alloys at all temperatures is higher than that of T3M, OT4, OT4-2, VT14, and VT5-1 alloys. AT3 alloy is heat resistant at up to 450° – 500°C, AT4 alloy at up to 500° – 550°C, and AT6 and AT8 alloys at up to 550°–600°C. AT3 and AT4 alloys retained their mechanical properties after being tested at 450°–650°C, while T3M alloy lost its ductility and VT14 alloy softened at these temperatures. Author

N67-37155# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

HEAT RESISTANCE OF ALLOYS IN THE QUATERNARY Ti-Al-Mo-V SYSTEM [ZHAROPROCHNOST' SPLAVOV CHETVERNOY SISTEMY Ti–Al–Mo–V]

Ye. P. Pylayeva and Ho Chi Min *In its* Phys. Met. of Titanium 30 Dec. 1966 p 397–404 refs (See N67-37121 22-17)

The authors investigated the heat resistance of Ti–Al–Mo and Ti–Al–(Mo: V = 1:1) alloys depending on composition and structure. The hot hardness method and centrifugal bending method were used. The plastic deformation rate was calculated according to the hot hardness of the Ti–Al–Mo alloy at 700°C. This rate for one identation corresponds to the plastic flow under similar pressure on the sample, from which the relative heat resistance can be calculated. The maximal heat resistance at 600°–800°C was given by a composition near the boundary of molybdenum solubility in the α-solid solution. For the Ti–Al–Mo and Ti–Al(Mo: V = 1:1) alloys with a constant aluminum content of 5, 10, 15 or 20%, the heat resistance is the same as in the second type of "content-heat resistance" diagram. For the Ti–Mo alloy the data for hot hardening at 700°C show that it is the same as for the third type of "content-heat resistance" diagram. The Ti–Al alloys are not deformed and may have value as cast heat resistant alloys. Author

N67-37156# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

HEAT RESISTANCE OF THE AT8 TITANIUM ALLOY DURING SHORT-TERM TESTS [ZHAROPROCHNOST' TITANOVOGO SPLAVA AT8 PRI KRATKOVREMENNYKH ISPYTANIYAKH]

N. M. Pul'tsin, M. P. Rumako, and V. B. Pokrovskaya *In its* Phys. Met. of Titanium 30 Dec. 1966 p 405–409 ref (See N67-37121 22-17)

In order to study the mechanical properties of AT8 alloy in relation to those of pure titanium and other titanium alloys, rectangular samples 2.7 mm thick, 10 mm wide, and 140 mm long, were placed in holders, heated by single-coil induction heaters and measured by optical pyrometer at temperatures of 800°, 850°, and 900°C and stresses of 3–20 kg/mm^2. After each sample had been brought to the prescribed temperature, it was held there until it was fractured, the time necessary to effect fracture being noted; the samples were then subjected to microscopic analysis. The results show that a decrease in stress increased the time to rupture at constant temperature, while an increase in temperature at constant stress decreased the time to rupture. The total creep of the samples was similar at different temperatures, but was achieved much more rapidly at higher temperatures. Author

N67-37157# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

HEAT STABILITY OF THE AT3 ALLOY AT TEMPERATURES OF 350 AND 400° [TERMICHESKAYA STABIL'NOST' SPLAVA AT3 PRI TEMPERATURAKH 350° I 400°]

K. P. Markovich and V. S. Mikheyev *In its* Phys. Met. of Titanium 30 Dec. 1966 p 410–418 refs (See N67-37121 22-17)

When AT3, AT6, AT8 alloys were tested for stability at 400° and 450°C for 300–7,000 hours the plasticity dropped at first but was restored to the initial value after 3,000 hours. The prolonged aging at 400°C led to hardening of the α phase grains and lowering of the plastic properties of the alloy. The paper concludes that aging of the AT3 alloy containing 2.7–2.8% Al and 1.26 or 1.53% Cr, Fe, Si and 350° and 400°C for 10,000 hours does not change the phase content. The AT3 alloy does not become brittle after 10,000 hours of aging, and the ultimate strength and elongation remain unchanged. The drop in plasticity is caused by the growth of the α phase grains and by hydrogenation. Author

N67-37158# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INFLUENCE OF CONDITIONS OF PLASTIC DEFORMATION AND SUBSEQUENT TREATMENT ON THE PROPERTIES OF SOME TITANIUM ALLOYS [VLIYANIYE USLOVIY PLASTICHESKOY DEFORMATSII I POSLEDUYUSHCHEY OBRABOTKI NA SVOYSTVA NEKOTORYKH TITANOVYKH SPLAVOV]

I. M. Pavlov, Yu. F. Tarasevich, and A. Ye. Shelest *In its* Phys. Met. of Titanium 30 Dec. 1966 p 419–426 refs (See N67-37121 22-17)

The authors investigated the effect of plastic deformation and subsequent cooling at different rates on the mechanical properties of several $\alpha+\beta$ b titanium alloys (martensite, types OT4, VT6 and VT14), where the β phase may be partially set at room temperature. The tests showed differences in hardness of VT14 alloy samples cooled under different conditions. Hardness was increased significantly by 40% compression and lowering of the temperature from 800°C. The effect of cooling rate on strength was noticeable only at rolling temperatures above 900°C. For 20% compression the ultimate strength changed smoothly as the rolling temperature varied. Relative narrowing was increased with compression at all rolling temperatures and cooling rates, while the temperature relationship was constant with a minimum at 1000°C and maximum at 700°C. Elongation was lowered during rolling at temperatures below 800°C with maximum elongation at moderate cooling rates beginning with 1100°C. Author

N67-37159# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STUDY OF THE BASIC PARAMETERS OF HOT AND COLD ROLLING OF SOME TITANIUM ALLOYS UNDER SPECIAL STRESS CONDITIONS [IZUCHENIYE OSNOVNYKH PARAMETROV GORYACHEY I TEPLOY PROKATKI NEKOTORYKH TITANOVYKH SPLAVOV V OSOBYKH USLOVIYAKH NAPRYAZHENNOGO SOSTOYANIYA]

I. M. Pavlov, Ye. G. Konstantinov, Yu. F. Tarasevich, and A. Ye. Shelest *In its* Phys. Met. of Titanium 30 Dec. 1966 p 427–440 refs (See N67-37121 22-17)

The aim of this investigation was to study the plasticity, stress and deformation of titanium alloys on a "200" rolling mill equipped with dynamometers for measuring the pressure on the rolls and torque meters for measuring the torque of the rolls. Type OT4, VT1, VT6, VT14 and VT15 alloys were selected; after being heated uniformly for 15–35 minutes the samples were rolled with an average compression of 20, 40 and 60% (with similar initial depth and variable final depth) at 500°–1100°C (every 100°C). The tests showed that at rolling temperatures above 900°C the specific pressure was relatively low. Only the VT15 alloy at a rolling temperature of 1100°C and compression of 20% has a specific pressure of about 9 kg/mm^2. The specific pressure increased more rapidly for the tested alloys than with technical titanium when the temperature dropped from 1100° to 900°C. The OT4, VT6, VT14 and VT15 alloys showed a lower plasticity than the VT1 alloy, the VT15 alloy having the lowest. Author

N67-37160# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SOME STUDIES OF THE STRUCTURE AND PROPERTIES OF THE VT5-1 ALLOY DURING HOT FORGING [NEKOTORYYE ISSLEDOVANIYA STRUKTURY I SVOYSTV SPLAVA VT5-1 PRI NAGREVE POD SHTAMPOVKU]

Ya. M. Dityatkovskiy, N. M. Pul'tsin, V. B. Pokrovskaya, and V. A. Vinogradov *In its* Phys. Met. of Titanium 30 Dec. 1966 p 441–448 refs (See N67-37121 22-17)

The problem of loss of metal during stamping requires special investigations to determine the optimal heating temperature which will insure the needed plasticity and minimum waste. The present paper investigated the added weight, the depth and properties of the changed layer of the VT5-1 alloy surface, and the alloy structure. Wedge-shaped samples were used for testing. The results showed that the VT5-1 alloy should not be heated above 1100°C for forging and stamping as the metal waste increases tremendously at these temperatures. When the temperature is increased during prolonged heat treatment, however, the decrease in the weight gain becomes less significant. Thus, at 900°C, when the heating duration changes from 1/2 to 2 hours, the weight gain drops by about 66%, while at 1100°C, the drop is only about 29%. The paper concludes that heating at temperatures above 800°C, and especially above 1100°C, leads to increases in weight of the alloys. Author

N67-37161# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CERTAIN SPECIFIC FEATURES OF THE HEAT TREATMENT OF THE AT3 ALLOY WITH A REDUCED CONTENT OF ALLOYING ELEMENTS [NEKOTORYYE OSOBENNOSTI TERMICHESKOY OBRABOTKI SPLAVA AT3 S PONIZHENNYM SODERZHANIYEM LEGI-RUYUSHCHIKH ELEMENTOV]

S. A. Yudina and B. K. Vul'f *In its* Phys. Met. of Titanium 30 Dec. 1966 p 449–456 refs (See N67-37121 22-17)

The aim of this investigation was to determine the conditions of heat treatment yielding the best mechanical properties, and showing a sufficient difference between the yield point and ultimate strength for an AT3 test alloy containing 2.5% Al, 0.9% Cr+Fe+Si+B, 0.03% H_2, 0.013% N_2, and 0.06% C. The billets cut from the bars were tested as cut with air hardening at 750°–1250°C (every 50°C), alone or plus aging of the hardened alloys at 300° or 400°C for 100 hours. The metal was held at 750°–1100°C for 1 hour and at 1150°–1250°C for 15 minutes. The alloys preserved high plasticity to a hardening temperature of about 850°C. Aging at 300°–400°C lowered the resiliency of forged samples, but did not affect the resiliency of alloys hardened at 800°–850°C. The paper concludes that lowering the content of alloying elements in alloy AT3 leads to high plasticity and impact strength with higher mechanical properties after air hardening at 825°–850°C. The alloy hardened under these conditions has high thermal stability. Author

N67-37164# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STUDY OF MUTUAL DIFFUSION OF TITANIUM WITH COPPER AND OTHER METALS IN SOLDERED JOINTS [IZUCHENIYE VZAIMNOY DIFFUZII TITANA S MED'YU I DRUGIMI METALLAMI PRIMENITEL'NO K PAYANYM SOYEDINENIYAM]

A. Ya. Shinyayev, V. V. Bondarev, and Ye. V. Sergeyeva *In its* Phys. Met. of Titanium 30 Dec. 1966 p 483–490 refs (See N67-37121 22-17)

Attempts were made to determine the mutual diffusion of titanium and other metals between 200° and 800°C in order to evaluate the service life of soldered joints. The tests were made with *silver*, copper, nickel, *Co–Ni* alloy, *chromium*, *rhodium* and *rhenium* on titanium and *AT3*, *AT4*, *VT1*, *VT4*, *VT5* and other titanium alloys. The samples were first etched in 40% sulfuric acid at 80±2°C for 10–40 minutes. The kinetics of the process of mutual diffusion were then studied by calculating the rate of mutual diffusion as a function of the working temperature and by finding the phases formed between the titanium and metals dissolved in the titanium. Microscopic analysis was used to observe the mutual diffusion. Results showed mutual diffusion of titanium develops at the following temperatures: *silver* and copper—above 500°C; *Co–Ni* alloy—above 600°C; chromium—above 700°C. Author

N67-37165# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

USE OF OPTICAL EMISSION MICROANALYSIS FOR THE STUDY OF TITANIUM ALLOYS [PRIMENENIYE OPTICHESKOGO EMISSIONNOGO MIKRO-ANALIZA DLYA ISSLEDOVANIYA SPLAVOV TITANA]

N. V. Korolev, S. A. Gorbunov, and S. A. Bogdanov *In its* Phys. Met. of Titanium 30 Dec. 1966 p 491–504 refs (See N67-37121 22-17)

Microspark analysis in argon is used in the analysis of alloys for nitrogen and oxygen. By the use of a weakened microspark and a guide groove it is possible to localize electrical charges to an area with a diameter up to 0.05 mm, with a minimum depth of the damaged layer of 10 microns in titanium alloys. Microspectral emission analysis of surface layers is irreplaceable for finding the causes of defects arising due to variation of alloy content. Layers up to 0.1 micron in thickness may be analyzed. The guide groove on the device allows one to localize the changes during microspectral analysis and thus determine the distribution of alloying elements in grains of the cast alloy Ti+5% Al+2% V. Microspectral analysis is also used together with etching of the microstructure, for instance, for Ti+5% Al+0.8% Mo, Ti+5% Al+0.8% Fe, and Ti+5% Al+2% V, indicating the presence of beta phase brittleness in these alloys. Author

N67-37166# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE PROBLEM OF DEFECTIVE INCLUSIONS IN TITANIUM INGOTS [K VOPROSU O DEFEKTNYKH VKLYUCHENIYAKH V SLITKAKH TITANA]

E. S. Fal'kevich, Ye. A. Lukevich, and A. N. Kucherenko *In its* Phys. Met. of Titanium 30 Dec. 1966 p 505–514 refs (See N67-37121 22-17)

Harmful inclusions in titanium ingots and semifinished products are characterized by high hardness and brittleness, resulting in disruption of the integrity of the metal. During production, the titanium sponge is oxidized. X-ray analysis of 2–5 mm fractions of various kinds of sponge showed the presence of a solid solution of titanium with gas inclusions. Investigations were performed with technical titanium ingots 130 mm in diameter made in a laboratory vacuum arc furnace. After stripping and etching in a solution of nitric and hydrofluoric acid, the ingots were tested for hardness and macrostructure. After this, a 5 mm layer was cut off, the surface was etched and the hardness was redetermined. Tests with grey-white oxidized sponge showed that the rutile in the melt is dissolved and inclusions are formed due to the presence of titanium oxynitride with a 4.203 A lattice. Author

N67-37167 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

METASTABLE PHASES IN TITANIUM ALLOYS AND THE CONDITIONS OF THEIR FORMATION [O METASTABIL'NYKH FAZAKH V SPLAVAKH TITANA I USLOVIYAKH IKH OBRAZOVANIYA]

S. G. Fedotov *In its* Phys. Met. of Titanium 30 Dec. 1966 p 515–532 refs (See N67-37121 22-17)

The physical and mechanical properties of alloys depend to a great extent on their structure, although heat treatment and mechanical working may change them. For titanium alloys, the basic theories of thermal and thermomechanical working have not yet been developed, much less practical methods for their implementation. In the present paper, the author reviews some of these questions. After hardening, titanium contains several metastable phases in the β field. These are known as the α', α'', ω and β phases. The α' phase is a super saturated solid solution of alpha-Ti with a hexagonal crystal lattice. The α'' phase differs from the α' phase by a rhombic lattice due to higher super saturation. The ω phase, found only by X-ray analysis, has a hexagonal crystal structure. These three phases are martensitic. The β solid solution has lower hardness, higher plasticity, a lower yield point, and a greater difference between the yield point and the ultimate strength than the other metastable phases. Author

N67-37168# IIT Research Inst., Chicago, Ill. Technology Center.

STRENGTH OF SINTERED FERROUS PARTS WITH INTERCONNECTED POROSITY Summary Report, 1 Jul. 1966–29 Jun. 1967

27 Jul. 1967 89 p refs

(Contract DA-36-038-AMC-4333(A))

(IITRI-86068-12; AD-656622)

A study of nine independent variables contributing to physical properties in sintered porous ferrous parts was made. A statistically designed experiment was utilized and the data analyzed through a computer program; an electrosketch attachment to the computer was used to obtain graphical presentation of the results. It was possible through proper combination of variables to obtain an ultimate tensile strength of 24,600 psi and 7% elongation in a specimen with 25% porosity and 19,600 psi UTS and 9% elongation in a specimen with 30% porosity. The most significant factors affecting ultimate tensile strength and elongation are shape, density, sintering temperature and time, and pressing rate. In addition, sintering atmosphere has a strong influence on elongation alone.

Dimensional change is most significantly affected by sintering temperature, time and atmosphere, particle shape, and pressing rate. Author (TAB)

N67-37218*# Martin Co., Baltimore, Md. Research Inst. for Advanced Studies.
BONDING, STRUCTURE AND MECHANICAL BEHAVIOR OF VANADIUM CARBIDE SINGLE CRYSTALS
R. G. Lye, G. E. Hollox, and J. D. Venables Jun. 1967 22 p refs
(Contracts NASw-1290; DA-31-124-ARO-D-467)
(NASA-CR-8804; TR-67-5; AD-655456) CFSTI: HC $3.00/MF $0.65 CSCL 11F

An approximate band structure for VC has been derived. From this, it is concluded that the bonding in VC arises primarily from interactions between orbitals on the metal atoms, and that this component of the bonding is stronger in VC than in TiC. Measurements of the compressive yield strength of VC0.85 single crystals over the range 900–1800C support this conclusion. However, a domain structure, associated with ordered carbon vacancies, has been observed in these crystals. The anisotropy introduced by such ordering may also contribute to the higher strength of this material. Author (TAB)

N67-37238# Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.
MECHANISM OF FATIGUE OF COPPER AT INTERFACES
R. G. Gates and W. A. Wood May 1967 144 p refs
(Contract Nonr-266(91))
(TR-51; AD-656427)

Studies are made of how torsion fatigue processes in pure copper with free surfaces differ (a) when the copper is covered with an electrodeposited coating (Ni, Cr, Au) and (b) when the copper contains embedded wires of tungsten as in a composite. The aim was to evaluate resulting fatigue performance from microstructural observations. Effects of coatings depend on fatigue amplitude, being in general deleterious at large amplitudes but inherently capable of effecting improvement at small amplitudes, especially if the coating is ductile as gold is. Embedded wires in the composites inevitably accentuated fatigue deformation and cracking of the copper matrix; but could lead to improved performance if used as crack stoppers. Examples of improved performance are given. Author (TAB)

N67-37239# Case Inst. of Tech., Cleveland, Ohio. Dept. of Metallurgy.
CONTROL OF CAST GRAIN SIZE OF STEEL CASTINGS—EFFECT OF STRUCTURE AND NONMETALLICS ON PROPERTIES Interim Report, 1 Oct. 1965–30 Sep. 1966
Peter F. Wieser and John F. Wallace Watertown, Mass., Army Mater. Res. Agency, 12 May 1967 95 p refs
(Contract DA-33-091-AMC-273(Z))
(AMRA-CR-64-04/3; AD-656476)

The relation of dendrite structure, nonmetallics and microporosity to solidification time and refinement by inoculation was investigated and correlated to mechanical properties of AISI 4335 steel castings. The dendrite spacing is determined by solidification time and significantly influenced by solute content. Titanium and boron effectively refine the secondary dendrite spacing; selenium tellurium and sulfur have the opposite effect. Titanium inoculation also nucleates equiaxed dendrites thereby reducing or eliminating the columnar dendritic structure. Increasing solidification time and amount or size of nonmetallics decrease the ductility. Improvements in ductility from grain refinement by either inoculation or shorter solidification time are caused by improved distribution or reduction of the size of nonmetallics. Microprobe analysis indicates no significant differences in the segregation behavior of the elements manganese and chromium from inoculation. A hypothesis concerning the formation of dendrite arms was postulated based upon measurements of solute distribution and existing theories of dendrite arm formation. Author (TAB)

N67-37257# Franklin Inst., Philadelphia, Pa. Research Labs.
A STUDY OF ALLOYING THEORY USING METASTABLE STRUCTURES Final Report, Jun. 1, 1966–Jun. 1, 1967
Rolf Stoering and Hans Conrad 1 Jun. 1967 73 p refs
(Contract N00014-66-C0231)
(F-C1869; AD-656051)

The phases and structures of liquid quenched and vapor quenched Cu-Ag alloys and liquid quenched Cu-Zn alloys were investigated by x-ray and electron diffraction and by electron transmission microscopy. For the Cu-Ag alloys a single phase FCC random solid solution with a maximum deviation of about +1% from Vegards law was only obtained for the thinnest regions (1000-3000 A) with a substrate temperature of -150 C. For the thicker regions and for higher substrate temperatures, segregated silver-rich FCC phases designated gamma double prime and alpha prime were obtained. The copper-rich beta prime phase was only observed for the highest substrate temperature of 50 C. A new hexagonal phase termed delta was found in very slight amounts in the liquid quenched Cu-Ag alloys. For the Cu-Zn alloys, the solubility of zinc in the alpha phase was increased to 48% by liquid quenching. Annealing of liquid quenched Cu50Ag50 alloys indicated the following sequence for the decomposition of the metastable phases: gamma prime (random) to gamma double prime (spinodal) to alpha prime (spinodal) to alpha prime + beta prime to alpha + beta (equilib.). Author (TAB)

N67-37296# Los Alamos Scientific Lab., N. Mex.
CARBIDE–GRAPHITE COMPOSITES Progress Report
K. V. Davidson, R. E. Riley, and J. M. Taub 15 Jun. 1967 15 p refs
(Contract W-7405-ENG-36)
(LA-3652-MS; PR-2) CFSTI: HC $3.00/MF $0.65

Data on the effect of composition, binder content, and contaminants in the as-received carbide and graphite powders are presented. The effect of pressure on deformation of extruded composites at high temperatures is discussed. Also presented are preliminary determinations of the effect of composition of TaC–C composites, TaC–NbC solid solution, and composites of TaC–NbC mixtures. Preliminary data on the dynamic elastic properties and electrical resistivity of NbC–C composites are given. Author (NSA)

N67-37309*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
DELAYED FRACTURE OF TITANIUM ALLOYS
M. Kh. Shorshorov and V. N. Meshcheriakov Huntsville, Ala., Redstone Sci. Inform. Center, Aug. 1967 19 p refs Transl. into ENGLISH from Novye Issled. Titanovykh Splavov (Moscow), 1965 p 278–288 Jointly supported by Army and NASA
(NASA-TM-X-60354; RSIC-689) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Results of delayed-fracture tests on an IMET-4 machine for VT6S, VT6, and VT14M Ti alloys, for a Ti alloy with low Al and Zr content, and for a Ti alloy with 3.7-percent Al. The fracture behavior and brittle properties of these alloys are compared. The mechanism involved is discussed noting the role of intergrain forces and absorbed gases. Author

N67-37337# Naval Ship Research and Development Center, Annapolis, Md.
EFFECT OF MEAN DEFLECTION ON THE LOW-CYCLE FLEXURAL FATIGUE BEHAVIOR OF ANNEALED 70–30 CUPRO–NICKEL
E. J. Czyryca and R. C. Schwab Jul. 1967 26 p refs
(Rept.-2445; AD-656574)

Hot-rolled and annealed 70-30 Cupro-Nickel alloy was tested by completely reversed deflection and zero-to-maximum deflection cycling in the low-cycle fatigue range. It was found that the fatigue life is solely dependent on total strain range. Neither large-mean tensile strains nor compressive strains affect the low-cycle fatigue life. Post yield strain hardening is appreciably greater under cyclic conditions than under static bending or tension. Author (TAB)

N67-37359# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
A THEORETICAL TREATMENT OF Zr/ZrO_2 EPITAXY
R. A. Ploc Jul. 1967 21 p refs
(AECL-2751) Available from Atomic Energy of Canada, Ltd., Chalk River: $0.50

An attempt has been made to establish theoretically the most favourable Zr/ZrO_2 (monoclinic) epitaxial relationship (based on Zr/Zr ion matching only), and to demonstrate that epitaxy of any type necessarily leads to the development of a large number of crystallites in the oxide film. Due to the relatively low symmetry of the monoclinic (4 ZrO_2) unit cell, at least 24 different ZrO_2 crystallite orientations should exist on oxidized zirconium (0001) planes. The relative orientations of these crystallites are defined by the substrate metal symmetry. Under conditions where oxygen transport along easy paths of diffusion is rate controlling, the higher the symmetry of the substrate atom packing (parallel to the oxide/metal interface), the greater the number of possible crystallite orientations, the smaller their likely size, and the greater the expected oxidation rate. Tables of monoclinic ZrO_2 d-spacings, interplanar angles and the unit translation vectors for the cell are given. Author

N67-37472# Battelle-Northwest, Richland, Wash.
REACTIONS OF SELECTED METAL–METAL COUPLES AT 1100°C
L. J. Kirby and H. T. Fullam Jun. 1967 20 p
(Contract AT(45-1)-1830)
(BNWL-421) CFSTI: HC $3.00/MF $0.65

Metal–metal couples were studied after exposures up to 4000 hr at 1100°C to characterize and evaluate the reactions that occurred. The couples studied included Hastelloy X, Ta, 304L stainless steel, Re, and Pt with metals and metal couples. The reactions of Hastelloy X and Hastelloy C with Re, W/25 Re, and Ta were studied following experiments where the temperature was cycled (700° to 1100°C). The slightly different behaviors of Hastelloy X, Hastelloy C, and 304L stainless steel in reactions with potential capsule liners suggested that minor alloy constituents play important roles in limiting the net diffusion of the couples. Other results are also discussed, and data are tabulated. NSA

N67-37477*# National Aeronautics and Space Administration, Washington, D. C.
OXIDE DISPERSION STRENGTHENED ALLOYS
Nicholas J. Grant (MIT), Howard J. Siegel (McDonnell Aircraft Corp.), and Robert W. Hall (NASA, Lewis Res. Center) 1967 30 p refs
(NASA-SP-143) GPO: HC $0.15/CFSTI: MF $0.65 CSCL 11F

The observations and conclusions resulting from the study of oxide dispersion strengthened alloys are summarized as follows: (1) Oxide dispersed alloys are at an early point in their development and considerable additional work must be undertaken to test their potential. (2) Matrices utilizing oxidation resistant systems will require considerable additional effort. The stability of the refractory oxide in such alloys is largely unknown and must be determined. (3) The mechanism of strengthening must be clearly established. Deformation and fracture studies must be pursued simultaneously. (4) Dispersoids other than oxides should be examined. (5) At least 5 years of increased support must be programmed. Important alloys of commercial stature can confidently be expected to result from such an expanded program. Author

N67-37480* International Information, Inc., Philadelphia, Pa.
THERMAL STABILITY OF DISPERSION-STRENGTHENED NICKEL [ZHAROSTOYKOST' DISPERSNO-UPROCHENNOGO NIKELYA]
T. V. Klavchenko, Ya. A. Shelement'yeva, N. P. Zhuk, and G. N. Karpman Washington, NASA, Jan. 1967 11 p refs Transl. into ENGLISH from Zashchita Metal. (Moscow), v. 2, 1966 p 312–317
(Contract NASw-1499)
(NASA-TT-F-10665) CSCL 11F

An experimental investigation is made of the heat resistance in air of high-strength nickel alloys containing certain oxides prepared by methods of powder metallurgy. It is shown that oxidation of nickel and its alloys with Al_2O_3, Cr_2O_3, TiO_2 and ZrO_2 up to 7 wt% in air at temperatures between 800° and 1200°C proceeds according to a parabolic law with the formation of a two-layer scale consisting of NiO. Author

N67-37510# Argonne National Lab., Ill.
NEUTRON IRRADIATION OF PURE METALS AND ALUMINUM–ZINC ALLOYS
James A. Horak Oct. 1966 83 p refs
(Contract W-31-109-ENG-38)
(ANL-7185) CFSTI: HC $3.00/MF $0.65

To determine the source of the initial electric conductivity rise during neutron irradiation of metals near 4°K and the induced resistivity produced by a fission–neutron spectrum, the metals Al, Cu, Ag, Au, Pt, Pd, Fe, and Ni were irradiated at about 4.5°K in the Argonne CP-5 VT-53 cryogenic facility. The initial resistivity increase that occurs in low-temperature neutron irradiation of metals is thermal in nature and appears to be due to gamma-ray heating. In addition, Al and the alloys Al-1.70, Al-3.41, and 5.27 a.% Zn in the quenched state and in the reverted state have been irradiated and isochronally annealed to study the effects of irradiation-induced lattice defects on the formation of Guinier–Preston (G.P.) zones. The damage rate for the Al and the alloys was the same, indicating that no G.P. zones formed during irradiation. The defects that are mobile below 77°K do not appear to affect G.P. zone formation in these alloys. The formation of G.P. zones began at the same temperature as the start of Stage III in Al, suggesting that the same defect, the vacancy, is responsible for both processes. Recovery was complete in Al at 260°K, but continued up to 400°K in the alloys. This indicates that there is an interaction between vacancies and Zn atoms that gives the vacancies a much longer lifetime in the alloy than in the Al. Irradiation greatly enhanced zone formation, especially in the reverted case, and the temperature of the start of zone formation and of the resistivity maximum was a function of defect concentration. These results suggest that the formation and growth of the G.P. zones in Al–Zn alloys are controlled by the point-defect concentration. Author (NSA)

N67-37562# California Univ., Berkeley. Dept. of Mineral Technology.
SELECTED VALUES OF THERMODYNAMIC PROPERTIES OF METALS AND ALLOYS
Ralph Hultgren, Raymond L. Orr, Philip D. Anderson, and Kenneth K. Kelley Apr. 1967 120 p refs Revised

Updated data are presented on the thermodynamic properties of metallic elements and binary alloys. The values presented cover phases and structures, gas properties, low temperature and high temperature data, and vapor pressures. Source bibliographies are included. M.G.J.

N67-37568# Denver Univ., Colo.
AN INVESTIGATION OF THE THERMODYNAMIC PROPERTIES OF SOME LIQUID TIN ALLOYS Final Technical Report
Monte J. Pool and J. Richard Guadagno Jul. 1967 23 p
(Contract DA-31-124-ARO-D-384)
(DRI-214; AD-655508)

The heats of solution of various elements in liquid tin have been investigated as a function of both temperature and composition. The elements studied included palladium, tellurium, rhodium, lithium, calcium, barium, strontium and lanthanum. The temperature range involved was from 700 K to 775 K and compositions from zero to 10 atomic percent solute were investigated. Heats of formation of several intermediate solid phases in the palladium-tin, tellurium-tin, rhodium-tin and lanthanum-tin systems have also been determined. Liquid densities of pure tin and palladium-tin alloys have been measured as a function of temperature and alloy composition. In all alloy systems the partial molar heat of solution of the solute in liquid tin is large and negative, ranging from a minimum value of -7600 calories/g-atom for tellurium at 775 K to a maximum value of -67,000 calories/g-atom for lanthanum at 725 K. The values for the other solutes involved are in the range -25,000 calories/g-atom to -42,000 calories/g-atom. This highly exothermic heat of solution indicates a high degree of association between solute atoms and solvent atoms in the liquid state. This conclusion is supported by both the heat of formation measurements and the density measurements. The heats of formation of the intermediate phases in the palladium-tin system are slightly more exothermic than the heat of solution of palladium in liquid tin. This difference can be attributed to the energy necessary to melt the solid intermediate phase, thus forming molecular type liquid. Density measurements on the palladium-tin system also indicate a high degree of solute-solvent bonding in the liquid state. The density of the liquid alloys is a linear function of palladium concentration and the deviation from the density of pure tin is approximately twice as great as would be expected from a random mixture of palladium and tin atoms. Interatomic spacings calculated from the liquid density measurements were approximately equal to those formed in the solid intermediate phases. Author (TAB)

N67-37576* Scientific Translation Service, La Canada, Calif.
EFFECT OF INTERSTITIAL ELEMENTS AND IRON ON CORROSION RESISTANCE OF COMMERCIALLY PURE TITANIUM IN HYDROCHLORIC ACID AND SULFURIC ACID
Shujiro Suzuki Washington, NASA, Oct. 1967 11 p refs
Transl. into ENGLISH from Boshoku Gijetsu, v. 15, no. 6, Jun. 1966 p 12–18
(Contract NASw-1496)
(NASA-TT-F-11279) CSCL 11F

The effect of interstitial elements and iron on corrosion resistance of commercially pure titanium in hydrochloric acid and sulfuric acid at room temperature and on their boiling temperatures was investigated. The results were summarized as follows: (1) Oxygen, nitrogen, or carbon, up to 0.5%, improved the corrosion resistance of commercially pure titanium in hydrochloric acid and sulfuric acid. (2) Addition of iron to the specimens containing oxygen, nitrogen, or carbon showed a tendency to decrease corrosion resistance. (3) The specimen containing a semi-transformed structure was inferior to equiaxed α structure as to corrosion resistance. (4) Anodic polarization was measured in hydrochloric acid by a Gerischer type of potentiostat. The above mentioned results were confirmed from the standpoint of anodic polarization. Author

N67-37582# Naval Ship Research and Development Center, Annapolis, Md.
STRESS–CORROSION STUDIES OF ALUMINUM ALLOY 5456-H321 IN SEAWATER
George A. Wacker Jul. 1967 27 p refs
(NSRDC-2436; AD-656573)

The stress-corrosion susceptibility of Aluminum Alloy 5456 in the H321 temper was investigated as a function of longitudinal, long transverse, and short transverse plate orientations. The alloy was found to be subject to pitting attack but immune to stress-corrosion cracking in flowing seawater at ambient temperature. Author (TAB)

N67-37592*# Vitro Labs., West Orange, N. J.
DEVELOPMENT OF A DISPERSION STRENGTHENED NICKEL BASE ALLOY USING THE HIGH INTENSITY ARC PROCESS Final Report
H. M. McCullough and M. Ortner 21 Aug. 1967 114 p ref
(Contract NAS3-7275)
(NASA-CR-54520) CFSTI: HC$3.00/MF$0.65 CSCL 11F

Alloy powders having a nominal composition of 60 Ni–20 Co–10 Mo–10W and containing dispersions of thoria, yttria, alumina, magnesia, and lanthana were prepared and evaluated. Based upon their dispersion characteristics, thoria and yttria dispersions were selected for larger scale preparation. Scaleup Procedures were developed for powder preparation and billets containing 0, 2, 4, and 7 volume percent thoria and yttria were prepared and evaluated by density and microhardness measurements as well as optical and electron metallography before and after thermal stability tests. The best of the billets produced contained 4% thoria. The yttrium-containing billets evidenced particle growth and inhomogeneous distribution. Clad billets without a dispersion oxide and containing 4% thoria were extruded to bar. The thoria dispersion was stable to the thermal stability test and to the extrusion process. The stress to rupture of this alloy was exceptionally low. Author

N67-37631# United Kingdom Atomic Energy Authority, Harwell (England). Chemistry Div.
STRESS CORROSION OF IRRADIATED TYPE 316 STAINLESS STEEL
C. F. Knights Jun. 1967 11 p refs
(AERE-M-1899) HMSO: 1s 9d

The investigation of the effect of irradiation with mixed thermal and fast neutrons on the susceptibility of type-316 stainless steel to stress corrosion cracking in $MgCl_2$ solution has been extended to stresses below 5,000 lb/in^2. There is a critical applied stress below which the time to failure is very dependent on stress. Fast neutron damage to the metal appears to be responsible for the enhanced susceptibility to stress corrosion cracking. Author

N67-37661 Lockheed-California Co., Burbank.
RF ENERGY TRANSFER IN TITANIUM
14 Jul. 1967 24 p refs
(LR-20846)

The much higher electrical resistivity of titanium and titanium alloys compared to aluminum and its alloys is expected to cause higher RF losses on airframes. Their effect is discussed. In airframe discontinuities, such as skin joints containing environmental sealers, the sudden surge of RF energy may cause severe sparking. This incidence was already observed with aluminum alloy joints, but the magnitude of its occurrence is unknown with titanium joints, particularly after aging. A related problem is the sparking of titanium as observed in machine tool operations. Molecular engineering has progressed recently to new process of electrolytical diffusion of

other metals into titanium, which changes surface properties such as hardness and ductility in the direction of desired improvements such as resistance to oxidation. Author

N67-37706# Lockheed Missiles and Space Co., Palo Alto, Calif.
INVESTIGATION OF THE EFFECT OF SURFACE CONDITIONS ON THE RADIANT PROPERTIES OF METALS. PART II. MEASUREMENTS ON ROUGHENED PLATINUM AND OXIDIZED STAINLESS STEEL
R. E. Rolling and A. I. Funai Wright-Patterson AFB, Ohio., AF Mater. Lab., Apr. 1967 264 p refs
(Contract AF 33(657)-11281)
(Rept.-6-77-67-27; AFML-TR-64-363, Pt. II; AD-655384)

Experimental results are presented to show the effect of surface roughness and of surface oxidation on the radiant properties of platinum and of 304 stainless steel. The radiant properties investigated include total and spectral normal, hemispherical, and directional emittance as a function of emission angle, polarization, temperature, and surface roughness or oxide film thickness. Emittance data are presented for five platinum samples with surface roughness values between 0.20 and 2.50 microns, rms, at five temperatures between 865 and 1645 K, and at selected wavelengths between 1 and 12 microns. Similar data are presented for nine stainless steel samples with surface oxide film-thickness values between 0 and 1.5 microns, at five temperatures between 535 and 1090 K. Variations in the radiant properties of each material are explained in terms of the differences in surface characteristics of the samples, or of changes in their surface characteristics as the result of annealing, recrystallization, and oxidation during the high temperature emittance tests. Methods used to evaluate the physical, chemical, and geometrical characteristics of the sample surface include: profilometry, optical and electron microscopy, x-ray and electron diffraction, and arc spectroscopy. The advantage and shortcomings of these methods are discussed and typical results are presented. Author (TAB)

N67-37733# Argonne National Lab., Ill.
CORROSION OF ALUMINUM ALLOYS BY FLOWING HIGH-TEMPERATURE WATER
J. E. Draley and W. E. Ruther Jan. 1967 20 p refs
(Contract W-31-109-ENG-38)
(ANL-7227; ANL-6677; ANL-6868; ANL-7000; ANL-7155)
CFSTI: HC $3.00/MF $0.65

A hypothesis is proposed relating the increased corrosion of Al alloys in rapidly flowing water (at high temperature) to precipitating colloidal corrosion products in the stream. A series of experiments showed that colloidal graphite and colloidal hydrated Al_2O_3 could significantly reduce the corrosion rate in 260°C water flowing at 7 m/sec. Corrosion rates approximating those obtained in static tests were achieved in the hydrated Al_2O_3 colloid solution. The total corrosion for one week in flowing 260°C water varied with small applied currents, increasing when the sample was made the cathode and decreasing when made the anode. As_2O_3 solution gave promise of being an effective corrosion inhibitor for high-temperature corrosion of Al in flowing water. A model of Al-corrosion mechanism is discussed. Author (NSA)

N67-37767# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
MECHANICAL PROPERTIES OF Al–Al_2O_3 ALLOYS: TESTING PROCEDURES AND EVALUATION OF DATA
D. G. Harman May 1967 14 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1802) CFSTI: HC $3.00/MF $0.65

Techniques have been developed to evaluate the elevated-temperature mechanical properties of Al–Al_2O_3 (SAP-type) alloys. Varying the strain rate over two orders of magnitude has explained much of the reported scatter in mechanical property data and provided data for creep-rupture predictions. The strain rate $\dot{\epsilon}$ in SAP is an exponential function of the stress σ: $\dot{\epsilon} = A\sigma^n$ with n being very high. This high n value is correlated with short-time tensile and creep-rupture behavior. Fractographic analysis shows ductile fracture under all testing conditions. Author (NSA)

N67-37851# Army Weapons Command, Rock Island, Ill. Research and Engineering Div.
FILTRATION OF ALUMINUM ALLOYS TO REDUCE OXIDE CONTENT
Richard B. Miclot Jun. 1967 26 p refs
(RIA-67-1507; AD-656456)

Several refractory and metallic media were tested for effectiveness in removing aluminum oxide from molten aluminum casting alloys. A technique was used by which a metal sample could be melted, filtered, and cast entirely in a nitrogen atmosphere. Eleven filter materials in granular form were evaluated for two commercial alloys, 195 and 356. The aluminum oxide content of each alloy was determined before and after filtering by chemical analysis, using a procedure previously developed. Single filter packs of carborundum, porous graphite, or nonporous graphite decreased the oxide content of 195 alloy; magnesite, alundum, mullite, or porous graphite were most effective for alloy 356. Author (TAB)

N67-37880 Hughes Aircraft Co., Culver City, Calif. Optical Properties Technical Information Center.
BERYLLIUM MIRRORS AT CRYOGENIC TEMPERATURES
John T. Milek 3 Jan. 1967 50 p refs
(OPSR-3)

A literature survey was made on the use of beryllium as a mirror and on the factors affecting its performance in a cryogenic environment. Factors affecting dimensional stability and adhesion of reflective coatings were of particular concern. A bibliography on 58 references is included. Author

N67-37901* Lehigh Univ., Bethlehem, Pa. Inst. of Research.
INVESTIGATION OF THE SOLIDIFICATION, STRUCTURE AND PROPERTIES OF EUTECTIC ALLOYS INCLUDING CONSIDERATION OF PROPERTIES CONTROL Semiannual Progress Report
R. W. Kraft Sep. 1967 15 p
(Grant NGR-39-007-007)
(NASA-CR-88858; SAPR-4) CSCL 11F

Abstracts and brief commentaries on four research thesis papers are presented. The investigations were on 1) the structure and elevated temperature mechanical behavior of unidirectionally solidified Ni–Ni_3Nb eutectic alloy, 2) galvano thermomagnetic effects in directionally aligned eutectics, 3) ambient temperature fatigue and fracture behavior of aligned Al–Al_3Ni eutectic, and 4) coarsening behavior of Al–Al_3Ni eutectic at elevated temperatures. L.S.

N67-37932# Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.
CORROSION AND HYDRIDING OF ZIRCALOY Quarterly Technical Progress Report, Jan. 1–Mar. 31, 1967
May 1967 28 p refs
(Contract AT(30-1)-3765)
(BAW-3765-2; EURAEC-1856; QTPR-2) CFSTI: HC $3.00/MF $0.65

Operational limitations for Zircaloy fuel cladding were studied. The program is divided into two tasks: corrosion and hydriding tests of Zircaloy under heat-transfer conditions to determine the quantity of H absorbed during service, and mechanical-property

tests of hydrided Zircaloy to determine the effect of H on cladding properties. The corrosion and hydriding test loop was operated initially on February 22, 1967. Specimen insertion started March 3, 1967, and was completed March 9, 1967. The calculated surface heat flux on all specimens is 600,000 Btu/hr-ft^2. Precorroding of specimens in 800°F, 500-psig steam to apply an oxide film and to introduce H_2 to simulate the condition of cladding at the end of core life began late in the first quarter. Test specimen data indicated that a 120-day exposure would produce the desired end-of-life conditions. After 90 days' exposure, the nine heat transfer specimens and their associated isothermal specimens were removed for an interim examination. All of the heat transfer specimens had undergone excessive oxidation and were no longer usable. Other methods of accelerating oxidation and hydriding are being investigated, so that the end-of-life specimens can be prepared without the risk of losing the specimens through excessive oxidation. (Additional specimens are being prepared to replace the lost specimens.) Hydriding of annealed and cold-worked tensile and burst test specimens was completed through 350-ppM H_2 content. Room-temperature tensile testing of these specimens was completed. Elevated-temperature tensile testing of annealed and cold-worked specimens was initiated and tests were completed through 650°F. A preliminary series of tests was performed to determine the dwell time necessary before testing to yield consistant tensile strength data. It was found that testing a specimen as soon as it reached test temperature yielded variable and inconsistent results, whereas holding the specimens at test temperature for at least 30 min resulted in consistent and reproducible data.
Author (NSA)

N67-37943# Aerojet-General Nucleonics, San Ramon, Calif. Nuclear Products and Services Group.
EVALUATION STUDY OF HASTELLOY X AS A NUCLEAR CLADDING Quarterly Progress Report, Jan. 1–Mar. 31, 1967
May 1967 95 p refs
(Contract AT(04-3)-368)
(AGN-8224) CFSTI: HC $3.00/MF $0.65

A duplex oxide film was formed on Hastelloy X at all exposure temperatures. The outer layer was found to be rich in Mn and Cr ($MnCr_2O_4$); the inner layer is composed largely of Cr (Cr_2O_3). The carbide particles present in exposed Hastelloy X were analyzed by point-counting techniques. The data indicated that the composition of the carbide varies between $M_{3.5}C$ and $M_{16}C$. Metallographic examination of low-Co and commercial tubing exposed for 7500 hr at 1900 and 2000°F was completed. Corrosion in the low-Co tubing was largely by internal oxidation. A major depleted zone was detected in the commercial material. Room-temperature tensile testing of sheet and tubing exposed at 1900°F revealed a general reduction in ultimate and yield strength as a function of exposure duration. Elongation properties of the sheet material varied only slightly as a function of exposure time. Data from an 1800°F, 1000 hr centrifugal creep test of 4 Hastelloy X heats in air were analyzed. In specimens where the total strain was less than 1%, a linear relationship existed between strain and time. NSA

N67-37949# Los Alamos Scientific Lab., N. Mex.
ONE-DIMENSIONAL ELASTIC–PLASTIC CALCULATIONS FOR ALUMINUM
Charles L. Mader 12 Jun. 1967 23 p refs
(Contract W-7405-ENG-36)
(LA-3678) CFSTI: HC $3.00/MF $0.65

Experimental measurements of the free-surface velocity of Al targets being shocked by flying Al plates moving at 0.10 and 0.041 cm/μsec are used to calibrate the Hooke's law–Von Mises yield model of elastic-plastic flow for Al at 33 and 84 kbar.
Author (NSA)

N67-37951# Bureau of Mines, Albany, Oreg. Metallurgy Research Center.
QUARTERLY METALLURGY PROGRESS REPORT, JANUARY 1–MARCH 31, 1967
31 Mar. 1967 38 p refs
(Contract AT(11-1)-599)
(USBM-RC-1288; QPR-34) CFSTI: HC $3.00/MF $0.65

Developments are reported for studies on high melting point carbides; Th alloy systems; UC–UN–UO in production of high temperature reactor fuels; and preparation and properties of W–Re–Mo alloys. NSA

N67-38013# California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials.
DISLOCATION VELOCITY IN COPPER AND ZINC
T. Vreeland, Jr. Apr. 1967 29 p refs Presented at the Colloq. on Dislocation Dyn. Conf., Seattle
(Contract AT(04-3)-473)
(CALT-473-13; CONF-670513-2) CFSTI: HC $3.00/MF $0.65

The stress dependence of dislocation velocity in Cu and in the basal and 2nd order pyramidal slip systems of Zn was measured. Dislocations were observed by the etch pit and Berg–Barrett X-ray techniques before and after application of short duration stress pulses. The velocity of dislocations of mixed edge-screw orientation in Cu and of basal edge dislocations in Zn was found to be a linear function of stress at room temperature. This data gives a value of the dislocation damping constant of 7×10^{-4} dyne sec/cm^{-2}, in good agreement with the value deduced from internal friction measurements in Cu. Evidence of an unusual stress and temperature dependence for the velocity of dislocations in slip bands on the 2nd order pyramidal slip system of Zn is reported.
Author (NSA)

N67-38017*# Southern Research Inst., Birmingham, Ala.
THERMAL AND MECHANICAL PROPERTIES OF A NONDEGRADED AND THERMALLY DEGRADED PHENOLIC-CARBON COMPOSITE
W. T. Engelke, C. M. Pyron, Jr., and C. D. Pears Washington, NASA, Oct. 1967 58 p refs
(Contract NAS1-5448)
(NASA-CR-898) CFSTI: HC $3.00/MF $0.65 CSCL 11D

Reported are results of a thermophysical property evaluation of a phenolic-carbon fiber material. The phenolic-carbon fiber material, a commercial ablative composite having the designation Narmco 4028, was evaluated in both the nondegraded (virgin) and thermally degraded (charred) forms. The thermal conductivity, heat capacity, and room temperature density were determined on both the virgin and charred material; and the total normal emittance was determined on the charred material only. The temperature ranges were −200°F (144°K) to 750°F (673°K) for the virgin material, and 1000°F (811°K) to 5000°F (3033°K) for the charred material. A general comparison of the thermal properties of the Narmco 4028 material with those of a previously evaluated phenolic nylon (NAS 1-2978) was performed. The carbon fibers caused the conductivity to be higher in both the virgin and charred materials, and caused the heat capacity to be lower in the virgin material. The emittance was lower for the Narmco 4028 char, consistent with the smoother and more reflective characteristic of the surface.
S.C.W.

N67-38055*# Scientific Translation Service, La Canada, Calif.
STABILITY OF TITANIUM–ALUMINUM ALLOYS DURING OXIDATION [STOYKOST' PRI OKISLENII SPLAVOV TITAN–ALYUMINIY]

V. V. Glazova Washington, NASA, Oct. 1967 5 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Metally (Moscow), no. 2, Mar.–Apr. 1967 p 219–221
(Contract NASw-1496)
(NASA-TT-F-11303) CSCL 11F

The resistance of titanium–aluminum alloys in air during oxidation at temperatures of 800 to 900°C was studied. Concentrations of these alloys ranged from 2 to 37 at% Al. Within the limits at which an alpha-solid solution occurs on a titanium base, aluminum decreased the oxidation rate of titanium at temperatures below 800°C. The Ti_3Al compound showed little resistance to oxidation, and the compound $TiAl_3$ was more resistant to oxidation in air. The differing resistance of these compounds during oxidation may be explained by their differing thermal stability at this temperature. Author

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N67-36891*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FABRICATION AND CHARACTERIZATION OF HOT ISOSTATICALLY PRESSED MgO
M. H. Leipold and T. H. Nielsen 1 Oct. 1967 10 p refs
(Contract NAS7-100)
(NASA-CR-88508; JPL-TN-32-1188) CFSTI: HC $3.00/MF $0.65
CSCL 11B

The technique of hot isostatic pressing was used to fabricate solid magnesium oxide, MgO, bodies of high purity with respect to metallic impurities to 90% to 95% density, with high translucency, and having a grain size of approximately 0.2μ. The densified material contained significant amounts of brucite, $Mg(OH)_2$, as a result of the presence of water which was in the starting material and was not removed during vacuum baking. The fabricated pieces showed large numbers of cracks which were apparently introduced into the compacts prior to densification. When the hot-pressed pieces were reheated, the brucite decomposed, the density increased and the porosity coalesced while grain growth occurred. The general technique appears to be usable for the fabrication of finely divided powders if improvements are made in powder degassing and predensification procedures. Author

N67-36801# Western Electric Co., Inc., Baltimore, Md.
SIMULTANEOUS EXTRUSION OF POLYETHYLENE AND POLYVINYL CHLORIDE COATINGS ON ELECTRICAL CONDUCTORS
G. E. Henning [1967] 15 p
(AD-656205)

The facilities described in this paper can be used for the same plastic in two different colors. They can, as has been pointed out, be used where two entirely different plastic materials are employed, such as polyethylene and PVC. Two or more conductors can, of course, be coated simultaneously, if the need arises. Moreover, either extruder can be operated entirely as a separate unit by simply inserting the proper tool assembly. The space occupied by the multicoat extrusion facilities, in terms of product turned out, is only about half of what would be required if two separate operations are employed. The saving in investment costs, on the same basis, would be about 40% of the cost of conventional equipment. Substantial operating economies over conventional equipment will result through reduced scrap, maintenance and the more efficient utilization of labor. Author (TAB)

N67-36974# Naval Air Engineering Center, Philadelphia, Pa. Aeronautical Materials Lab.
OCEANOGRAPHIC EFFECTS ON PLASTIC ENGINEERING MATERIALS
Henry J. Lee 23 Jun. 1967 25 p
(NAEC-AML-2628; AD-655817)

The continuing investigation of oceanographic influences on a wide spectrum of plastic engineering materials, reinforced laminates and other plastics, has been in progress. Submersible Test Unit II-2 (STU II-2) test panel array, which is discussed, represents one segment of this continuing effort. This panel array was submerged 13 April 1965 for 402 days at a depth of approximately 2,370 feet in the Port Hueneme Pacific Ocean Area. Due to circumstances beyond control, mechanical evaluation of specimens were not conducted until approximately eleven months after retrieval. However, the evaluation indicated that, in the main, the mechanical properties were adversely affected to a greater degree than those of specimens in previous exposures. Author (TAB)

N67-37069# Olin Mathieson Chemical Corp., New Haven, Conn. Chemicals Group.
FIBER REINFORCED BORANE-BASED RESIN COMPOSITES: A NEW APPROACH TO OXIDATIVE THERMAL STABILITY
Hansjuergen A. Schroeder and James T. Trainor (Raybestos-Manhattan, Inc.) Aug. 1967 12 p refs Presented at the 12th Natl. SAMPE Symp.
(Contract Nonr-3395(00))
(TR-38; AD-656088)

A series of novel boron-based polymers was evaluated as binders in heat and oxidation resistant reinforced plastic structures. The preponderance of data concerns resin/asbestos composites which were found to exhibit a remarkable retention of their physical properties after heat-aging for 1000 hours in air. Despite current limitations such as resin insolubility, relatively severe processing conditions and hydrolytic instability of the fabricated parts, application of these systems can be foreseen for service as structural components when extended use in air between 700 and 900F is required. Author (TAB)

N67-37065# Dow Corning Corp., Midland, Mich. Physics/Chemistry Labs.
INVESTIGATION OF THE PHYSICAL–CHEMICAL NATURE OF THE MATRIX-REINFORCEMENT INTERFACE Technical Report, 1 Jun. 1965–1 Jun. 1966
O. Johannson Dec. 1966 130 p refs
(Contract AF 33(615)-1667)
(AFML-TR-65-303, Pt. III; AD-655736)

This study of the nature of the interfaces in reinforced plastics provided physical chemical evidence which supports postulated covalent bonding mechanisms at glass-coupling agent-resin interfaces. These conclusions were derived from studies of the interactions of monofunctional silanes and silane coupling agents with E-glass, aerosil, and polymethylmethacrylate surfaces. Experimental methods employed were radiochemical tracer techniques, electron microscopy, and calorimetric heats of immersion. Author (TAB)

N67-37067*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
THE EFFECT OF INTERFIBER DISTANCE AND TEMPERATURE ON THE CRITICAL ASPECT RATIO IN COMPOSITES

R. W. Jech and R. A. Signorelli Washington, NASA, 1967 33 p refs Presented at the 12th Ann. Symp. on Advan. in Struct. Composites Sponsored by the Soc. of Aerospace Mater. and Process Engr., Anaheim, Calif., 10–12 Oct. 1967
(NASA-TM-X-52347) CFSTI: HC $3.00/MF $0.65 CSCL 11D

The effect of interfiber distance and temperature on the critical aspect ratio (minimum length to diameter ratio) in a fiber composite was examined using a modified pull-out test. Tungsten fiber–copper, iron fiber–lead, and iron fiber–cadmium specimens were used. Variation of the critical aspect ratio as a function of interfiber distance was determined for the iron–lead and iron–cadmium systems. Critical aspect ratio as a function of temperature was determined for the tungsten–copper system. Reduction of the interfiber distance increased the apparent shear strength of the matrix as indicated by a reduction of the critical aspect ratio. A rapid increase in the critical aspect ratio was noted at test temperatures in excess of 1000°F. Author

N67-37078*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
GLASS-, BORON-, AND GRAPHITE-FILAMENT-WOUND-RESIN COMPOSITES AND LINERS FOR CRYOGENIC PRESSURE VESSELS
Morgan P. Hanson Washington, NASA, 1967 28 p refs Presented at the Cryog. Polymers Conf., Cleveland, 25–27 Apr. 1967
(NASA-TM-X-52350) CFSTI: HC $3.00/MF $0.65 CSCL 11D

Tensile and interlaminar shear strengths are reported of NOL rings at 297°, 77° and 20°K. Filament translation efficiencies are compared. Cryogenic cyclic life of aluminum liners in glass filament-cylinders is reported. Author

N67-37081* California Inst. of Tech., Pasadena. Firestone Flight Sciences Lab.
FAILURE CRITERIA FOR VISCOELASTIC MATERIALS Semiannual Status Report, 1 Mar.–31 Aug. 1967
W. G. Knauss Sep. 1967 11 p refs
(Grant NsG-172-60)
(NASA-CR-88528; GALCIT-120; GALCIT-SM-67-10) CSCL 11J

The problem of wave propagation in viscoelastic materials was considered, and it was shown how the initial temperature affects wave propagation and that a step pulse traveling initially with the glassy wave speed changes shape through a transition. The result is that the final wave shape is again a step pulse traveling with the lower wave speed corresponding to the rubbery modulus. A numerical, finite element analysis of an elliptically perforated rubber sheet undergoing large deformations is being conducted. The solution incorporates nonlinear material behavior through the use of a neo-Hookean stress–strain law. Figures depict the stress and strain concentration factors at the root of an ellipse having an aspect ratio of 10, and three-dimensional plots for different values of the gross strains. Theoretical calculations based on linear analyses are being attempted to calculate the rate of fracture progression in sheet geometries from stress analysis and basic material behavior. M.G.J.

N67-37114*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
INVESTIGATION OF THE EFFECT OF MATERIAL PROPERTIES ON COMPOSITE ABLATIVE MATERIAL BEHAVIOR Final Report
P. B. Cline and F. E. Schultz 17 Apr. 1967 209 p refs
(Contract NAS3-6291)
(NASA-CR-72142) CFSTI: HC $3.00/MF $0.65 CSCL 11D

The influence of material properties on the ablative performance of the silica phenolic, and graphite phenolic, and graphite epoxy materials was analytically investigated. Those properties which have the greatest effect on the surface recession were established. The reactions for the property variation within a given material are stated along with the measured range of their values. Author

N67-37116# Enjay Labs., Linden, N. J.
SOME RECENT STUDIES OF ELECTRICAL GRADE FILLERS IN BUTYL RUBBER AND OTHER INSULATION MATERIALS
W. F. Fischer [1954] 29 p refs
(ELD-22622; AD-656191)

Talc imparts a smooth surface to extruded articles, increases resistance to flow of uncured compounds, and may be of use in nonelectric molded and proofed goods where resistance to permeation by gases or liquids is desired. Promotion of the filler with a chemical agent like Elastopar improves uncured properties and increases cured modulus 20-30 per cent. Overall processing and physical property data on platy talc compounds detailed in the paper show no significant deficiencies in comparisons with calcined clay, calcium carbonate and other types of talc fillers in butyl rubber. A one-step mixing procedure for butyl-platy talc compounds is described. Comparisons of dielectric strength of platy talc with other fillers in polyethylene, polypropylene and polyvinyl chloride plastics indicate the platy talc sustains the high dielectric strength of the plastics at 1800-2000 volts per mil. Nonplaty mineral fillers tend to decrease resistance to electrical failure. Author (TAB)

N67-37178# General Electric Co., Schenectady, N. Y.
COMPOUNDING OF G.E. ELECTRICAL GRADE SILICONE RUBBER
1967 16 p
(AD-656328)

Fillers for an electrical grade silicone rubber are evaluated with regard to electrical properties, dielectric constant, and % power factor. Stability in water soaks are correlated with the water absorption of the compound, as measured by mechanical pick up, and the importance of low water absorption fillers stressed. Author (TAB)

N67-37179# General Electric Co., Pittsfield, Mass.
IRRATHENE 201 IRRADIATED POLYETHYLENE—A NEW CABLE INSULATION
P. A. Goodwin [1967] 6 p
(AD-656261)

Irrathene 201 irradiated polyethylene offers all of the advantages of conventional polyethylene: (1) Low loss characteristics at all frequencies. (2) High dielectric strength. (3) Excellent barrier to moisture. (4) Chemical inertness. (5) Low specific gravity. (6) Good mechanical properties. In addition, it may be used at higher temperatures than conventional polyethylene and is highly resistant to environmental stress cracking. It offers the possibility of encapsulation of conductors or various electrical devices to provide a homogeneous, water-tight case of excellent properties. It should be considered for use wherever layer insulation such as varnished cloth, oil-impregnated paper or plastic films are now used or in new applications wherever the encapsulation technique is of interest. Author (TAB)

N67-37219# Los Alamos Scientific Lab., N. Mex.
CMF-13 RESEARCH ON CARBON Summary Progress Report Ending May 1, 1967
Morton C. Smith 1 Jun. 1967 20 p
(Contract W-7405-ENG-86)
(LA-3693; Rept.-1) CFSTI: HC $3.00/MF $0.65

Research was undertaken on carbon and graphite to determine their behavior as engineering materials, to improve the raw materials

and techniques involved in their manufacture. Micromerograph size-distribution analyses, surface area analyses, and density measurements were made on filters of coke flour and graphite flour. Research is being carried out on binders used for industrial carbons and graphites. Experiments were undertaken to examine the effects of various blending procedures on extruded and molded products of both resin-bonded and pitch-bonded graphites. Samples from a number of extruded graphite rods were examined to evaluate their crystalline anisotropies. Measurements of density, bulk velocity, shear velocity, Young's modulus, and internal friction were made on two samples of molded graphite. Tensile properties were determined for various samples. NSA

N67-37254# Raytheon Co., Waltham, Mass. Research Div.
AN INVESTIGATION FOR FABRICATING AND EVALUATING THE PROPERTIES OF CHEMICALLY VAPOR DEPOSITED ALUMINA AND MAGNESIA Interim Report, Jan.–Mar. 1967
Ray C. Ellis Apr. 1967 73 p refs
(Contract DA-19-066-AMC-318(X))
(S-946; AD-655585)

The chemical vapor deposition technique for aluminum oxide was investigated using the reaction 2AlCl3 + 3H2O yields Al2O3 + 6HCl. Transparent, theoretically dense, alpha-aluminum oxide was produced. If the pressure or deposition rate was increased, the product became white and opaque due to the inclusion of many small voids. If the deposition temperature was decreased or the partial pressure of water in the reaction increased, there was a tendency to co-deposit the theta modification. Both isotropic and anisotropic aluminum oxide could be produced, depending on process conditions. Two problems which presently limit the thickness of the transparent material are the rather narrow range of suitable reaction conditions and the nozzle design, which allows a product buildup on the gas inlet tube. Author (TAB)

N67-37255*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF FILM PROCESSING ON CRYOGENIC PROPERTIES OF POLY(ETHYLENE TEREPHTHALATE)
Roger E. Eckert (Purdue Univ.) and Tito T. Serafini Washington, NASA, 1967 22 p refs Presented at the Cryog. Polymers Conf., Cleveland, 25–27 Apr. 1967
(NASA-TM-X-52351) CFSTI: HC $3.00/MF $0.65 CSCL 11I

The effects of stretch temperature, heat-set temperature and heat-set time on the cryogenic mechanical properties of PET film were studied by using a two level factorial experiment. Squares of amorphous PET sheet were given a simultaneous biaxial 3X stretch in a laboratory film stretcher at either 85 or 95°C. The levels of heat-set temperature and time investigated were 190 and 210°C, and 15 and 120 seconds, respectively. Crystallinities of the films were determined by the density-gradient technique. Tensile properties were measured in liquid nitrogen (77° K) and in liquid hydrogen (20° K). Biaxial burst properties were obtained in liquid nitrogen. It was found that processing variables significantly affect the stress–strain properties of PET film at cryogenic temperatures. These results and encouraging values of flexibility offer leads for possible use of specially processed PET films for cryogenic space applications. Author

N67-37262# Stanford Research Inst., Menlo Park, Calif.
PROCESSING OF CERAMICS, SURFACE FINISHING STUDIES Final Technical Report, 23 Mar. 1966–22 Apr. 1967
Rudolf Sedlacek and Eldon P. Farley May 1967 53 p refs
(Contract NOw-66-0383-d)
(Rept.-12; AD-654209)

An experimental grinding facility was established so that a systematic study can be made of the effects of grinding variables on the strength of ceramics. The equipment employed is a high precision universal cylindrical grinding machine incorporating several features which make it particularly suitable for this work. The material on which the effect of grinding variables is being evaluated is a 99.5% alumina body whose mechanical properties are well documented from previous studies. The strength of test specimens, which is the main criterion for the evaluation of the effects of grinding, is measured by the expanded ring test method developed at Stanford Research Institute. In machining test specimens three basic grinding steps are involved: facing, external cylindrical grinding, and internal cylindrical grinding. All machining is done with diamond wheels and the individual variables under study are related to the rate of material removal and the quality of the surface of the finished piece. Necessary skills have been developed, the performance of the equipment has been evaluated, a number of work procedures have been established, and several special fixtures and accessories have been designed and built. The equipment in its present state is capable of producing a wide range of grinding conditions in a highly controllable and reproducible manner. Author (TAB)

N67-37306*# Midwest Research Inst., Kansas City, Mo.
SYNTHESIS AND EVALUATION OF NEW HIGH TEMPERATURE POLYMERS FOR COATING APPLICATIONS Technical Summary Report, 26 Jun. 1964–25 Sep. 1966
L. W. Breed, R. L. Elliott, L. M. McDonough, W. H. Burton, and M. E. Whitehead 25 Sep. 1966 176 p refs
(Contract NAS8-11338)
(NASA-CR-88757) CFSTI: HC $3.00/MF $0.65 CSCL 11C

Experimental work is reported on the synthesis, characterization, and evaluation of organic and semiorganic polymers useful as coatings that will withstand high temperatures, high vacuum, and radiation. Poly(phenylenesiloxanes), suitable for the preparation of films, were prepared by the condensation of arylenedisilanols with cyclic siloxazanes. The polymers, which represented a variety of structures and were characterized in detail, had high molecular weights and good high- and low-temperature properties. Several were screened under high vacuum-ultraviolet irradiation conditions. High molecular weight poly(benzoxazoles) were prepared, but no satisfactory method was found for preparing poly(benzoxazole) films. Attempts to prepare titanium chelate polymers, titanoxanosiloxanes, and boroxanosiloxanes produced only low molecular weight products. An investigation of model systems for ferrocene polyesters and boron chelate polymers did not reveal any potentially useful methods of polymerization. Several other potentially useful polymer systems were examined briefly. Author

N67-37321# Army Engineer Research and Development Labs., Fort Belvoir, Va.
STUDY OF HEAT-RESISTANT PLASTIC LAMINATE FROM THE STANDPOINT OF A MECHANICAL-CHEMICAL EQUATION OF STATE
S. Goldfein Jun. 1967 24 p refs
(Rept.-1901; AD-656443)

The object of the study was to analyze the complex degradation history of a heat-resistant epoxy resin laminate using the mechanical-chemical equation of state. A further object was to determine if weight-loss measurements at elevated temperatures could be used to predict long-term rupture strength. Master rupture curves drawn using a second-order parametric form of the equation of state largely clarified the anomolous behavior of the laminate. It was not found possible to predict the long-term mechanical properties from weight-loss data. Author (TAB)

N67-37443# Aerospace Corp., El Segundo, Calif. Labs. Div.
THERMAL DIFFUSIVITY OF CARBONS AND GRAPHITES IN THE TEMPERATURE RANGE FROM 1800 TO 3300°K
J. Kasper and E. H. Zehms Jun. 1967 33 p refs
(Contract AF 04(695)-1001)
(TR-1001(9250-02)-2; SSD-TR-67-116; AD-655786) CFSTI: HC $3.00/MF $0.65

Improved and new steady periodic heat flow methods for the direct measurement of the thermal diffusivity of carbons and graphites at very high temperatures were developed. Their main features are techniques that overcome the difficulties arising from the radiative environment with thermal conductance much greater than that of the material under investigation. The thermal diffusivities of various carbons and graphites were determined with these techniques and were found to be essentially independent of temperature throughout the entire range investigated. It is argued that the observed c-direction conduction in pyrolytic graphite is probably not of intrinsic nature, but is at best a small component of the a-direction conduction caused by tilt angle variations of the microcrystallites. It is further suggested that the heat conduction in graphites at high temperatures is substantially of electronic nature, a point supported by Lorenz numbers based on more recent data. The essentially temperature-independent diffusivity of graphite reflects, then, the behavior of ordinary metals above the Debye temperatures. Author (TAB)

N67-37461# Naval Air Engineering Center, Philadelphia, Pa. Aeronautical Structures Lab.
INVESTIGATION OF THE EFFECTS OF RADIANT HEAT ON THE STRUCTURAL EFFICIENCY OF AIRCRAFT AND MISSILE COMPONENTS MADE OF GLASS-FIBER-REINFORCED PLASTIC LAMINATES Final Engineering Report
E. Alter 30 Apr. 1967 54 p refs
(NAEC-ASL-1112; AD-655442)

The investigation was performed to compare, by means of a controlled experiment, the effects produced by radiant heat with those produced by convective heat in aircraft structures fabricated of glass-fiber-reinforced plastic laminates. A complete 6-factor experiment was designed and analyzed statistically. The six main factors were heat source, size effect, shielding, quality control, post-cure temperature, and heating rate. Each factor had two levels; the experiment was replicated twice. Three separate studies with various thermal conditions were made with flat beams and cylinders. In all the studies, the analysis-of-variance method showed no difference between the effects of radiant and convective heat at the 5-percent level of significance. The difference between two manufacturers quality controls were significant in some of the studies, but the difference due to shieldings was not significant. Size effect results were considered inconclusive because of some of the experimental problems involved. Author (TAB)

N67-37535*# Studebaker Corp., Cincinnati, Ohio. CTL Missile/Space Technology Div.
DEVELOPMENT OF AN ANALYTICAL TECHNIQUE FOR PREDICTING PROPERTIES OF COMPOSITE MATERIALS Annual Summary Progress Report, Jul. 1, 1963–Jun. 1, 1964
R. E. Silbernagel 25 Jun. 1964 74 p
(Contract NAS8-11036)
(NASA-CR-88470; CPB-02-1185-63) CSCL 11

Studies designed to demonstrate the validity of the parametric charting portion of the MPT (material prediction technique) are reported. This was accomplished by testing composite materials in a selected hypothetical thermal environment which was a convective application. The technique is based upon the development of parametric charts in which the properties of various parent materials are correlated with the properties of composites of these parent materials in various proportions. Composite mats of preselected constituents were manufactured and test specimen were fabricated. These specimen were tested to determine properties of the materials which are both dependent and independent of specific operating and environmental conditions. Upon completion of these first tests, parametric charts were developed. A second series of tests were performed which confirmed the validity of the charting portion of the MPT. Cross correlation of these charts was to be made to develop a composite in which each of the various parameters were to be optimized by varying the percentage composition of the various constituents and the processing history in accordance with the mode and composition predicted by the cross correlation. Due to the success of the charting technique, it is recommended that this technique be applied to an actual thermal insulation problem such as might be encountered on the Saturn vehicle. It is also recommended that the parametric approach to material properties, as used with the material prediction technique MPT, be put on a computerized basis. S.C.W.

N67-37538# Picatinny Arsenal, Dover, N. J. Plastics and Packaging Lab.
APPLICATION OF REACTION RATE ANALYSIS TO THE MECHANICAL PROPERTIES OF GLASS-REINFORCED PLASTICS
E. McAbee and D. W. Levi Aug. 1967 29 p refs
(PA-TR-3556; AD-655857)

Tensile strength data for 181 glass-cloth-reinforced polyester and epoxy were analyzed according to a modified rate equation. While these materials show somewhat more scatter than was encountered with the thermoplastic materials the agreement was such that a reasonable prediction of behavior could be made. Author (TAB)

N67-37548# Army Weapons Command, Rock Island, Ill. Research and Engineering Div.
GREASES—EFFECTS OF COMPOSITION AND SHEAR RATE ON MECHANICAL STABILITY
Robert L. Young Apr. 1967 24 p refs
(RIA-67-1075; AD-655275)

Seventeen greases were shear worked at ambient temperatures by three different shear methods. The approximate shear rates of these methods were 20/sec., 450/sec., and 10,000/sec. The breakdown of the greases was evaluated by consistency changes as determined by the 1/4 scale worked penetration, ASTM Federal Test Method D-1403. It was found that the greases made with synthetic thickeners were usually more shear stable than those made with soap base thickeners. In a majority of greases the higher the rate of shear, the greater the breakdown. Author (TAB)

N67-37549# Central Lab. TNO, Delft (Netherlands).
MECHANICAL PROPERTIES OF HIGHLY FILLED ELASTOMERS. VI. INFLUENCE OF FILLER CONTENT AND TEMPERATURE ON ULTIMATE TENSILE PROPERTIES
Cornelius J. Nederveen and Hendricus W. Bree May 1967 46 p refs
(Contract N62558-4375)
(CL-67/34; ONR-TR-6; AD-655634) CFSTI: HC $3.00/MF $0.65

Results are presented of stress-strain tests performed at various temperatures and strain rates on materials filled with various amounts of sodium chloride particles with a mean size of 0.1 mm. Stress and strain at rupture decreased with increasing filler content. For each material investigated it was possible to construct the well-known failure envelope by means of which the results could be described adequately. The dewetting of the particles in the rubbery matrix, sometimes resulting in a maximum in the stress-strain curve, is ascribed to failure of the rubber between the particles and not to failure of the rubber-salt bond, because the

dewetting maximum was dependent on temperature and time in the same way as the rupture properties of the unfilled material. The results are compared with earlier investigations, e.g. high speed tensile tests and creep experiments, and a good agreement is found. Author (TAB)

N67-37551*# Monsanto Research Corp., Dayton, Ohio.
IDENTIFICATION OF VOLATILE CONTAMINANTS OF SPACE CABIN MATERIALS Technical Report, Nov. 1965–Feb. 1967
J. V. Pustinger, Jr. and F. N. Hodgson Wright-Patterson AFB, Ohio, AMRL, Jun. 1967 211 p ref
(NASA Order T-31248-G; Contract AF 33(615)-3377)
(NASA-CR-88636; AMRL-TR-67-58) CFSTI: HC $3.00/MF $0.65 CSCL 11I

Ninety-eight candidate materials for space cabin construction were tested to establish possible volatile gas-off and oxidation products. These materials could be potential cabin contaminants. Tests conditions were designed to simulate the normal space cabin environment. After pretreatment at 0.1 torr and at 25°C, candidate materials were stored in bench-scale simulators for 14 days at 68°C, and for 30, 60, and 90 days at 25°C, in a 5 psia oxygen atmosphere with 20–40% relative humidity. Individual components of the volatile contaminants were identified and the quantities evolved were estimated by gas chromatographic and mass spectrometric analyses. Paints and coatings, prepared immediately before test, gave off considerable amounts of entrapped solvents. Lesser, but significant, amounts of contaminants result from oxidation and from hydrolysis. In some cases, large increases in carbon monoxide levels were observed when the storage temperature was increased from 25°C to 68°C. In addition to the gas-off experiments, a cryogenic system for serial trapping of atmospheric contaminants was constructed. Gas chromatographic and mass spectrometric analyses were performed on four samples of atmospheres from bio-environmental systems. Author

N67-37573*# RAI Research Corp., Long Island City, N. Y.
DEVELOPMENT OF A PROTOTYPE PLASTIC SPACE ERECTABLE SATELLITE
Vincent F. D'Agostino and Preston Keusch Washington, NASA, Sep. 1967 219 p refs
(Contract NAS5-3923)
(NASA-CR-892) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The development of procedures and data for construction are discussed for a prototype space erectable plastic passive communications satellite of spherical design with a diameter of 425 ft. using the plastic effect. Research resulted in the development of a crosslinked polyethylene metal laminate weighing 1.58×10^{-3} lbs./ft.^{2} (resulting in a satellite weight of 896.6 lbs.) and capable of withstanding solar pressures when fabricated into a sphere with a 425 ft. diameter. Experimental data and theoretical calculation indicate that a 0.30 mil perforated polyethylene film electrolessly plated with 15 ± 10^{-6} inches of copper on both sides would be satisfactory to withstand buckling pressures within the weight conditions specified. Prototype items were constructed and delivered following a detailed testing program on the various materials used in construction. Additionally, the procedures necessary for the scale-up and production of a 425 foot diameter spherical passive communications satellite were investigated. Author

N67-37659*# United Aircraft Corp., East Hartford, Conn. Research Labs.
INVESTIGATION OF THE KINETICS OF CRYSTALLIZATION OF MOLTEN BINARY AND TERNARY OXIDE SYSTEMS Quarterly Status Report, 1 Jun.–31 Aug. 1967
J. F. Bacon 1 Oct. 1967 8 p
(Contract NASw-1301)
(NASA-CR-88884; QSR-8) CFSTI: HC $3.00/MF $0.65 CSCL 11B

Thirty-one new glass batches were devised. These new compositions may be placed into three groups, a four component system in which the mol ratio of magnesia to alumina has been increased to 6 and which includes silica and a rare earth, older glasses which could not previously be successfully fiberized because of too great surface tension where an attempt was made to adjust their surface tension by vanadia additions, and older glasses previously melted with high purity rare earth chemicals which were prepared with inexpensive low purity earth conglomerates subetituted. From the 181 glass compositions studied to date forty-four varieties of glass fibers have been successfully prepared and many additional test data for these glass fibers are included. These data continue to verify the conclusion that several of the glasses have values for the ratio of Young's modulus to density comparable to any glass now available commercially even though the glasses are made from non-toxic materials. The data also indicate that after storage for a month in a typical laboratory atmosphere, the glass fibers retain higher strength values than do glasses prepared from competitive patent prescriptions. Author

N67-37731*# Scientific Translation Service, La Canada, Calif.
EXPERIMENTAL TECHNIQUES OF STUDYING PYROLYSIS OF HIGH POLYMERS SUBJECTED TO RAPID HEATING [TECHNIQUES EXPERIMENTALES D'ETUDE DE LA PYROLYSE DES HAUTS POLYMERES SOUMIS A DES ECHAUFFEMENTS RAPIDES]
Samuel Kohn Washington, NASA, Sep. 1967 23 p refs
Transl. into ENGLISH from Rech. Aeron. (Chatillon-sous-Bagneux), no. 88, 1962 p 27–39
(Contract NASw-1496)
(NASA-TT-F-11238) CSCL 11I

The techniques described permit the study of high-temperature degradation effects in materials protecting missile reentry bodies by ablation under approximately operational conditions. Mass loss is thermogravimetrically measured using rapid techniques at different temperatures as a function of time. Differential thermal analysis ascertains the endothermic or exothermic nature of the pyrolysis reactions and determines the temperature range in which they are found. Finally, the gas flow from the material is measured. All tests are limited to 60 sec. duration. The principal value of the results is comparative, for they very clearly indicate the effect of heating rate on pyrolytic phenomena. Author

N67-37897# ManLabs, Inc., Cambridge, Mass.
HIGH PRESSURE CONSOLIDATION OF VACUUM ENCAPSULATED TUNGSTEN COMPACTS Final Report
Edward V. Clougherty and James Elling May 1967 14 p
Prepared for Calif. Univ., Livermore, Lawrence Radiation Lab.
(Contract W-7405-ENG-48)
(UCRL-13298) CFSTI: HC $3.00/MF $0.65

A total of nineteen encapsulated W powder compacts were forwarded to ManLabs, Inc. for high pressure consolidation. The processing conditions of pressure, time, and temperature were specified. The actual conditions employed were generally as specified, but some experimental difficulties were encountered in the measurement and attainment of temperature in several consolidation processings. The pressure and time specifications were generally well satisfied. Such experimental difficulties are not uncommon in the present stage of development of high pressure technology. The experimental details of the pressure and temperature calibration procedures and a description of the apparatuses employed are

provided. It was not possible to procure submicron powders of HfB_2 and HfO_2. These powders were to be blended with a particular lot of W powder. Such blends were intended for a processing of compacts formulated to provide dispersion strengthening of the same batch of W previously high pressure processed. This type of strengthening can not be effected unless the dispersoid is present in submicron sizes. Alternate methods of formulating mixtures of W and dispersoids suitable for dispersion strengthening can be employed but such procedures could not make use of a particular batch of W, hence the objectives of the planned study could not be accomplished. It was agreed to delete the procurement, blending, and processings associated with this aspect of the study. Author (NSA)

N67-38058# Ordnance Research Inc., Fort Walton Beach, Fla.
BINDER STUDY—VISUAL CAST FLARES Final Summary Report
Hal R. Waite and Y. Arikawa 27 Mar. 1967 24 p refs
(Contract N00164-67-C-0086)
(RDTR-92; AD-655821)

Techniques and castable formulations were developed that produce luminous efficiencies between 42,000 and 45,000 candle-seconds/gram; no diameter effect was apparent in the range of 1.5 to 4.95 inches. The early experimental effort on the use of compounded polyesters and urethanes was discontinued in favor of the use of glycidyl methacrylate and similar vinyl monomers. This class of monomer gives the desired solvation of the perchlorate (with concomitant increase in viscosity of the binder for improved particle wetting) and a controlled exotherm in large diameter castings. Final physical properties are attained after 24-hour post-cure. The use of sodium perchlorate in lieu of the insoluble sodium nitrate yielded a casting slurry of lower viscosity at constant binder percentage; the use of sodium nitrate was therefore discontinued. The use of a trimodal distribution of magnesium improved casting ease at the 15 percent binder level. Early program effort concentrated on the use of kraft paper cases in order to simulate standard flare hardware. The recognized tunnel effect reduced the luminance values obtained and masked differences attributable to the binder type and content. Composition efficiencies were then obtained on free standing grains, displacement cast and the cylindrical surfaces inhibited. The program demonstrated the feasibility of cast illuminating flares based on commercial materials. Author (TAB)

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N67-36686# State Univ. of New York, Stony Brook.
INTEGRAL REPRESENTATIONS OF INVARIANT STATES ON B-ALGEBRAS
O. Lanford and D. Ruelle [1966] 12 p refs
(Grant AF-AFOSR-1096-66)
(AFOSR-67-1559; AD-655336)

Let Q be a B^* - algebra with a group G of automorphisms and K be the set of G-invariant states on Q. We discuss conditions under which a G-invariant state has a unique integral representation in terms of extremal points of K, i.e. extremal invariant states. Author (TAB)

N67-36764# California Univ., Los Angeles. Western Management Science Inst.
IMPLICIT ENUMERATION USING AN IMBEDDED LINEAR PROGRAM
Arthur M. Geoffrion May 1967 22 p refs *Its* Working Paper No. 120
(Contract Nonr-233(75))
(AD-655444)

Integer programming by implicit enumeration has been the subject of several recent investigations. Computational efficiency seems to depend primarily on the ability of various tests, applied to the constraints in connection with 'partial solutions,' to exclude from further consideration a sufficiently large proportion of the possible solutions. Most of the simpler or more appealing of these tests can be applied at reasonable computational cost essentially to only one constraint at a time. Two main approaches have been suggested for mitigating this limitation. TAB

N67-36827# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
RECURSIVE ALGORITHMS FOR PATTERN CLASSIFICATION
Colin C. Blaydon Mar. 1967 172 p refs
(Contracts Nonr-1866(16); Nonr-1877(07); Nonr-1866(32))
(TR-520; AD-655239)

This research is concerned with recursive algorithms for constructing decision functions in pattern classification problems. The principal objective of this thesis is to provide a comprehensive interpretation that will be a common basis for (I) discussing the heretofore fragmented collection of existing algorithms and (II) deriving new algorithms. All of the algorithms will be discussed as methods for minimizing pre-specified criterion functions. In deterministic pattern classification problems (those problems where there are a fixed, finite number of patterns each having a unique classification), the recursive algorithms are interpreted as special cases of a general gradient descent algorithm. In stochastic pattern classification problems (where the classification of a particular pattern is not unique but is expressed as a probability), the recursive algorithms are found to be special cases of a general stochastic approximation algorithm. This algorithm is the stochastic analog of the deterministic gradient descent algorithm. The stochastic approximation algorithm is also useful for approximating probability distribution and density functions. In this problem, there is no information about the unknown distribution of density functions being approximated. Only samples of the random variables are available. In the final chapter, the recursive algorithms are applied to problems in optimal control, estimation, and pattern classification. Author (TAB)

N67-36828# Naval Research Lab., Washington, D. C.
ACCURATE AND STABLE NUMERICAL SOLUTIONS TO THE SCHROEDINGER EQUATION
Carl A. Rouse 23 Jun. 1967 28 p refs Sponsored in Part by NSF
(NRL-6558; AD-655439)

A new method has been presented for accurate and stable numerical solutions of ordinary differential equations. Applied to the Schrodinger equation the two essential features of the method are (a) simultaneous Taylor expansions between space steps delta rho of the wave function R(rho) and the slope of the wave function m(rho), and (b) the derivation of initial values through either an exact series solution of the Schrodinger equation valid at or near the origin, or through an approximate analytical solution valid for all n and l to terms of order rho superscript 2 - O(rho superscript 2). As far as the author can determine, the present results represent the first known accurate and stable numerical solutions of the radial hydrogenic Schrodinger equation. With the present ability to

calculate eigenvalues to nine or more significant figures and eigenfunctions to nine or more decimal places, the present method becomes an alternative to perturbation and variational methods. TAB

N67-36829# Stanford Univ., Calif. Dept. of Computer Science.
AN ALGORITHM FOR AN AUTOMATIC GENERAL POLYNOMIAL SOLVER
M. A. Jenkins and J. F. Traub (Bell Telephone Labs., Inc., Murray Hill, N. J.) 21 Jul. 1967 42 p refs Presented at the Symp. on Constructive Aspects of the Fundamental Theorem of Algebra, Rueschlikon, Switzerland, 5–7 Jun. 1967
(Contract Nonr-225(37))
(CS-71; AD-655230)

A restriction-free algorithm for a general automatic polynomial equation solver is described and its implementation as an ALGOL program is discussed. The First Stage of the algorithm is a preprocessing step which guarantees that the iterative Second Stage will converge. The zeros are found one or two at a time and in increasing order of magnitude which guarantees stable deflation. The algorithm automatically decides when to switch to Stage Two and the decision is made easily for a zero which is easy to calculate. Flowcharts for the program are given and numerical results are presented for 3 hard problems. The present program is a research program and certain improvements will have to be made before the program could serve as a general library routine. Author (TAB)

N67-36877* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SPECTRAL DECOMPOSITION OF THE CROSS-CORRELATION FUNCTION
Robert E. Cummings, Quintin D. Peasley, Jack W. Bradford, and William E. Hinds 18 May 1967 79 p ref
(NASA-TM-X-53609) CSCL 12A

The development and evaluation of numerical and logical procedures for computing co-spectral and quad-spectral density estimates from given cross correlation data points, together with the first and second differences at these points, are documented. The relative merits of linear versus logarithmic spacing of the time lags for the chosen cross correlation points are tested and demonstrated. These results fail to show a sufficient advantage in using logarithmic spacing to overcome the inherent operational and numerical error problems; thus, linear spacing of time lags is recommended for use with these numerical procedures. Author

N67-36879* Volt Technical Corp., Washington, D. C.
SOLUTION OF SYSTEMS OF ORDINARY DIFFERENTIAL EQUATIONS BY THE METHOD OF EXPANSION IN POWER SERIES ON QUICK-RESPONSE COMPUTERS
V. S. Nikolayev 5 Sep. 1967 9 p refs Transl. into ENGLISH from Zh. Vychislitel'noi Mat. i Mat. Fiz. (Moscow), v. 5, no. 4, Jul.–Aug. 1965 p 608–614
(Contract NAS5-12487)
(NASA-CR-88516; ST-MAT-10-642) CSCL 12A

The question of utilization of the method of expansion in series by powers for the solution of systems of ordinary differential equations is considered. The fundamental principles are expounded for the programming of actions with series. Possibilities of practical application of a specialized program for actions with series during the solution of certain problems by means of a computer are discussed. Author

N67-36934# California Univ., Berkeley. Dept. of Mathematics.
PARTIAL REGULARITY RESULTS FOR NON-LINEAR ELLIPTIC SYSTEMS
Charles B. Morrey, Jr. Jun. 1967 35 p refs
(Contract Nonr-222(62))
(AD-655293)

The paper discusses solutions z = (z superscript 1, ... z superscript N), in which each z superscript i belongs to the Sobolev space (H subscript k, superscript mi) (G) for some mi = or > 1, of the equations the integral over G of (summation from i = 1 to i = N, summation sign, subscript (absolute value of alpha = or < mi), zeta superscript i, prefix subscript alpha, A subscript i, superscript alpha, (x, D3) dx) = o for all zeta epsilon C subscript c, superscript infinity symbol, (G). TAB

N67-36952# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
OPTIMUM QUANTIZATION OF RANDOM SEQUENCES
Herbert Gish May 1967 151 p refs
(Contract Nonr-1866(16))
(TR-529; AD-656042)

Whenever information is to undergo digital processing it must be given a quantized representation. The quantizers investigated are those which are optimum with respect to a mean square error criterion for stationary input sequences. They are permitted to have memory and it is shown that they belong to the class of quantized feedback systems which includes delta-modulators and predictive quantization systems (differential pulse-code modulation). Emphasized are the application of quantization to digital communication and considered are the analog to digital and digital to analog operations of the quantizer to be performed respectively by a transmitter and receiver. The analysis of the quantization system with a linear receiver is considered in depth. The results for random sequences are made applicable to the transmission of time continuous information by considering the random sequence to have been obtained by sampling a time continuous process, and by using an interpolator to reconstruct the continuous process from the quantized samples. Several examples are presented for the transmission of a Gauss-Markov process. The effect of bandlimiting the continuous process before sampling is also investigated. Comparisons are made with PCM and the rate distortion function. TAB

N67-36962*# Brown Univ., Providence, R. I. Center for Dynamical Systems.
ON THE LINEARIZATION OF VOLTERRA INTEGRAL EQUATIONS
R. K. Miller May 1967 18 p refs
(Contract NAS8-11264; Grants NGR-40-002-015; AFOSR-693-67)
(NASA-CR-88543) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A mathematical description is presented on the linearization of Volterra integral equations. All known proofs of the fact of the asymptotic stability of the linear system depend on the fact that solutions of the linear system decay exponentially or the equivalent fact that there exists a quadratic Liapunov function for the linear system. The purpose of this study is to provide a theory of linearization of equations under very general assumptions. The essential tool in the analysis is a tool used in place of the usual estimates from ordinary differential equations. R.U.

N67-36969# RAND Corp., Santa Monica, Calif.
DYNAMIC PROGRAMMING AND THE HAMILTON-JACOBI METHOD OF CLASSICAL MECHANICS
S. E. Dreyfus Jul. 1967 34 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5116-1-PR; AD-655767)

Three methods, using dynamic programming concepts and principles, for analytically solving a variational problem. The conventional dynamic programming method is described and

illustrated and two alternatives to the conventional method are developed. While the derivations are new, the results are equivalent to those of the classical Hamilton-Jacobi method of solving optimization problems. Author (TAB)

N67-36973# Information Research Associates, Inc., Lexington, Mass.
ON THE COEFFICIENTS OF A WIENER CANONICAL EXPANSION FOR THE LIKELIHOOD FUNCTION OF A CONTINUOUS MARTINGALE
Donald B. Brick 12 Jun. 1967 21 p refs
(Contracts AF 49(638)-1631; AF 33(615)-3758)
(AFOSR-67-1555; TR-10; AD-655594)

Analytical forms for the coefficients and for the sum of the squares of the coefficients of a Wiener Canonical (Hermite-Laguerre) expansion of the likelihood function of a stochastic process may be readily obtained if that process is a zero initial-value stationary (wide-sense), orthogonal-increment continuous Martingale. These coefficients are simple functions of the parameter of the process, sigma (subscript o, superscript 2). It is shown that the coefficients containing odd subscripts vanish as expected, while if sigma (subscript o, superscript 2) = 1, all coefficients vanish except the first one (i.e., the coefficient for the zeroth order Hermite polynomials). This suggests a matching possibility, whereby the process amplitude variation may be matched to the expansion. The expression for the asymptotic value of the coefficients for large order (index) is derived and is shown to behave as the inverse fourth root of the index. Author (TAB)

N67-36981# RAND Corp., Santa Monica, Calif.
A LOWER BOUND FOR THE δ-NIELSEN NUMBER
Robin B. S. Brooks and Robert F. Brown (Calif. Univ., Los Angeles) Jul. 1967 20 p refs Prepared jointly with Calif. Univ., Los Angeles
(Grant NSF GP-4018)
(P-3634; AD-656306)

This paper is concerned with the number of solutions of three kinds of equations. Let f,g : X approaches Y and h : X approaches X be maps, and let y sub 0 be a member of Y. The equations we will study are (1) f(x) = g(x), (2) f(x) = y sub 0, and (3) h(x) = x. In a previous paper, the first author defined a lower bound N for the number of solutions of these equations which remains such a lower bound when f,g, and h are moved through homotopies. The number N is called the Delta-Nielsen number of the equation. TAB

N67-37013# Hebrew Univ., Jerusalem (Israel).
NON-STANDARD ANALYSIS WITHOUT TEARS (AN EASY INTRODUCTION TO A. ROBINSON'S THEORY OF INFINITESIMALS)
Moshe Machover May 1967 61 p refs
(Contract F61052-67-C-0055)
(TR-27; AD-656401)

A simplified framework is given for A. Robinsons non-standard analysis, using a small fragment of set theory rather than type theory. Various topics in topology are discussed in the light of Robinsons theory. Author (TAB)

N67-37037# Carnegie Inst. of Tech., Pittsburgh, Pa. Management Sciences Research Group.
FLOWS IN ARBORESCENCES
Fred Glover Jul. 1967 61 p refs
(Contract Nonr-760(24))
(RR-102; AD-656626)

Efficient algorithms are given for four network flow problems that arise in solving integer programs by truncated enumeration. The first problem is to find a maximum weight (or minimum cost) flow in an arborescence with upper and lower bound capacities on each arc. Each of the remaining three problems is to find a maximum or minimum flow across some arc of the arborescence (respectively, the terminal arc, a source arc, or an intermediate arc), such that the total weight of the flow is not less than a specified value. Theorems are given characterizing the properties of optimal solutions to these problems, providing the basis for the algorithms proposed. Necessary and sufficient feasibility criteria are provided for the first problem, and a theorem is also given characterizing the relation between optimal integer and continuous solutions to the last three problems. A numerical example is solved in the concluding section. Author (TAB)

N67-37056# Florida State Univ., Tallahassee. Dept. of Statistics.
SURVEILLANCE PROBLEMS: POISSON PROCESS UNDER COSTLY SURVEILLANCE
C. Bradley Russell Jun. 1967 32 p refs
(Contract Nonr-988(13))
(M124; AD-654898)

This paper is concerned with optimal strategies for controlling a one-dimensional Poisson production process under costly surveillance. Observations may be taken and repairs may be made at any time at positive cost. A form of the long run average income is used as the criterion for comparing strategies. The class of non-randomized stationary strategies which allow production only when the process is observed in one of a finite number of states is shown to contain an optimal strategy under a certain assumption of monotonicity of the income function. Author (TAB)

N67-37083# Carnegie Inst. of Tech., Pittsburgh, Pa. Management Sciences Research Group.
BAYESIAN ANALYSIS OF SYSTEM READINESS
D. P. Gaver, Jr. Jul. 1967 22 p refs
(Contract Nonr-760(24); Grant NSF GP-6296)
(Rept.-105; AD-656031)

The paper describes three problems relevant to the estimation of system readiness. A Bayesian approach is taken. Author (TAB)

N67-37094# Wisconsin Univ., Madison. Dept. of Statistics.
AN ASYMPTOTIC EXPANSION FOR POSTERIOR DISTRIBUTIONS
R. A. Johnson May 1967 16 p refs
(Contract Nonr-1202(00); Grant NSF GP-3816)
(TR-114; AD-656033)

We obtain an asymptotic expansion for the centered and scaled posterior distribution when the observations are drawn from a member of the one-parameter exponential family. The first few terms are calculated in order to show the manner in which the prior distribution enters. Author (TAB)

N67-37189# RAND Corp., Santa Monica, Calif.
MULTIVARIATE LOGARITHMIC AND EXPONENTIAL REGRESSION MODELS
C. A. Graver and H. E. Boren, Jr. Jul. 1967 147 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-4879-PR; AD-655768)

This study analyzes a multivariate exponential regression function. Two basic types of error assumptions are examined: multiplicative (logarithmic model) and additive (exponential model). The usual method of taking natural logarithms of the regression relationship and then using linear least-squares estimators for the parameter estimates assumes that the error is multiplicative. Analysis shows that only the estimate of the parameter in the coefficient term and its distribution are affected by whether the

hypothetical regression function is equal to the expected value (the mean) of the dependent variable Y, or to the median. The other parameter estimates, their distribution, and the prediction interval of Y are not affected. The study also examines the exponential, or additive, model in which the error is assumed to be normally distributed and added to the function. This leads to the more difficult problem of least-squares estimation of a nonlinear form. Such a solution is not exact and may not be unique. Methods of comparing the two models are given. The bulk of the Memorandum describes, lists, and gives instructions for use of the Multivariate Logarithmic and Exponential Computer Program. TAB

N67-37242# RAND Corp., Santa Monica, Calif.
A STOCHASTIC DYNAMIC MULTIMODE TRANSPORTATION MODEL
J. L. Midler Jul. 1967 39 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5250-PR; AD-655344)

A mathematical model and two solution techniques for selecting preferred combinations of different transportation modes over consecutive periods in the face of uncertainty. Some acquaintance with control theory, dynamic programming, and nonlinear programming is assumed. The model is formulated as a problem of optimal stochastic control theory. It assigns individual commodity classes to various carriers, determines which supply points serve which destinations, and reroutes carriers where they will be most effective. It takes account of differential transit times and costs, availabilities, costs of storage, over-supply and shortages. The system dynamics consist of inventory balance equations relating end-of-period stocks at each point to inflows and outflows. An alternative method is also presented for cases in which the assumptions required for the dynamic programming algorithm are not valid. TAB

N67-37278* Maryland Univ., College Park. Computer Science Center.
ON SOLVING NONLINEAR EQUATIONS WITH A ONE-PARAMETER OPERATOR IMBEDDING
Gunter H. Meyer Sep. 1967 37 p refs
(Grant NsG-398)
(NASA-CR-88708; TR-67-50) CFSTI: HC $3.00/MF $0.65 CSCL 12A

An operator homotopy approach is used to develop constructive methods for solving nonlinear operator equations. A differential equation is associated with each homotopy from which iterative schemes can then be derived. This approach is shown to be particularly suitable for operators with a globally invertible Frechet derivative and for operators in a partially ordered space which possess a certain subinverse. Author

N67-37298# State Univ. of New York, Stony Brook.
INTEGRAL REPRESENTATIONS ON COMPACT CONVEX SETS (CHOQUET THEORY)
Oscar E. Lanford, III 30 Aug. 1966 24 p refs Presented at the Summer Symp. on Theoret. Phys., Stoney Brook, N. Y.; Sponsored by AFOSR and N. Y. State Sci. and Technol. Found.
Its Internal Rept.-4
(Grant AF-AFOSR-1096-66)
(AFOSR-67-1560; AD-655379)

These notes attempt to give an introduction to the theory of integral representations on compact convex sets developed first by G. Choquet and later by numerous other authors. They do not aim at completeness, but only at the presentation of the central results. The notes do attempt to give the proofs in sufficient detail to make them accessible to the non-specialist. It is assumed the reader has an elementary knowledge of point set topology, integration theory on locally compact spaces, and the theory of locally convex topological vector spaces. TAB

N67-37334# Wisconsin Univ., Madison. Dept. of Statistics.
ASYMPTOTIC NORMALITY OF THE MAXIMUM LIKELIHOOD ESTIMATE IN MARKOV PROCESSES
George G. Roussas May 1967 15 p refs
(Contract Nonr-1202(17); Grant NSF GP-6242)
(TR-115; AD-656032)

In the present paper asymptotic normality of the maximum likelihood estimate in Markov Processes is established under conditions slightly weaker than the ones usually found in the literature. Author (TAB)

N67-37352# Aerospace Corp., El Segundo, Calif.
COLLECTED RESULTS ON NUMERICAL RESEARCH
Thomas R. Parkin and Leon J. Lander Apr. 1967 93 p refs
(Contract AF 04(695)-1001)
(TR-1001(9990)-2; SSD-TR-67-115; AD-656704)

A compilation of results from research in number theory involving the use of a digital computer is presented. The research is related to characteristics of prime numbers, equal sums of powers of integers, differences of powers of integers, equal sums of fifth powers, and the classic problem of finding two equal sums of two biquadrates. Author (TAB)

N67-37386*# Maryland Univ., College Park. Computer Science Center.
BOUNDS FOR HORNER SUMS
Manfred Reimer Sep. 1967 13 p refs
(Grant NsG-398)
(NASA-CR-88701; TR-67-52) CFSTI: HC $3.00/MF $0.65 CSCL 12A

The study of the effect of round-off in Horner's scheme leads to the problem of estimating the absolute values of the so-called Horner sums. The problem is solved under the condition that the polynomial is either an odd or an even function and that its maximum -norm does not exceed the value one. Except for a few specific cases, the Chebyshev-polynomials then turn out to be the maximizing polynomials. Author

N67-37389*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE ENHANCEMENT OF DATA BY DATA COMPRESSION USING POLYNOMIAL FITTING
William Kizner 1 Oct. 1967 17 p refs
(Contract NAS7-100)
(NASA-CR-88762; JPL-TR-32-1078) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Optimal data compression by polynomial fitting is discussed from a rigorous theoretical point of view. By means of information gained from smoothness properties of the functions based on the constructive theory of functions, it is shown how estimates can be improved over the usual minimum-variance unbiased estimates. A conclusion is that measurements should be made as often as possible. The theory developed here extends beyond the applications given to polynomial fitting. Proof is given for various theorems concerning biased estimators. One theorem, given on the result of using an approximation to the covariance matrix of the errors of the observations, is believed to be new. A similar technique might be used in estimating any set of parameters whose magnitude decreased to zero in a reasonable way. Author

N67-37440# Illinois Univ., Urbana. Coordinated Science Lab.
AN IMPROVED METHOD OF FINDING ALL LARGEST COMBINABLE CLASSES
Gerald J. Lipovski Aug. 1967 28 p refs
(Contract DA-28-043-AMC-00073(E))
(R-362; AD-656608)

Several algorithms, such as a row-column minimization algorithm and an asynchronous machine assignment algorithm, require finding the largest sets of combinable elements from a list of pairwise combinable elements. The paper presents a technique for finding these sets which is generally faster than the one presently in use. Further, the presentation of this technique uncovers an interesting theory about combinability. TAB

N67-37444# Yale Univ., New Haven, Conn.
COWLES FOUNDATION FOR RESEARCH IN ECONOMICS AT YALE UNIVERSITY. PART VIII: THE NONSYMMETRIC GAME: THE GENERALIZED BEAT-THE-AVERAGE SOLUTION
Richard Levitan and Martin Shubik 26 Jun. 1967 10 p *Its* Cowles Foundation Discussion Paper No. 227
(AD-655626)

In previous papers we have considered an especially violent form of market behavior which in two-person games has been called the maximize the difference solution and in general n-person games the beat-the-average solution. There is a natural extension of beat-the-average to the nonsymmetric case which in terms of interfirm comparison may serve as a benchmark for extreme competition. This solution we call maximize the share of industry profits. A closely related problem is discussed which has an interpretation in terms of different levels of cooperation. The solution of the cooperation parameter model gives the necessary computation method for the iteration procedure to calculate the maximum profit share solution. This is done in a computer program written by one of the authors. TAB

N67-37458# Naval Research Lab., Washington, D. C. Electronics Branch.
DISCRETE FINITE FOURIER TRANSFORMS: A TUTORIAL APPROACH
D. A. Swick 29 Jun. 1967 23 p refs
(NRL-6557; AD-656577)

A discrete, finite time series of N points f sub n n = 0, 1, 2,..., N - 1, often arises, for example, in the sampling of continuous data. This time series can be expressed as the finite series f sub n = Summation, k = 0 to k = N - 1, of (F sub k e to the power (2 pi i k n/N)), n = 0, 1, 2,..., N - 1, where the coefficients F sub k, to be interpreted as frequency values, are given by F sub k = 1/N Summation, n = 0 to n = N - 1, of (f sub n e to the power (-2 pi i k n/N)), k = 0, 1, 2,..., N - 1. Experimental errors inherent in f sub n will, of course, be reflected in F sub k. Given the original time series f sub n, however, it is exactly (i.e., without approximation) represented by F sub k at the N points of interest. These formulas are derived from basic principles, and their relationship to digital analysis of data sampled from continuous signals is discussed. In particular, the efficient use of the recently popular algorithms for rapid machine computation of Fourier transforms is explained. Although the results obtained are for the most part well known in the literature, it is felt that the importance of these transforms warrants a complete and notationally consistent exposition. Author (TAB)

N67-37642# Kansas State Univ., Manhattan.
INTRODUCTION TO APPLICATION OF QUASILINEARIZATION TO THE SOLUTION OF NON-LINEAR DIFFERENTIAL EQUATIONS
E. S. Lee, S. S. Chen, L. T. Fan, and C. L. Hwang 30 Mar. 1967 34 p refs *Its* Special Rept.-78 *Its* Kansas State Univ. Bull. Volume 51, no. 7
(Grant AF-AFOSR-463-66)
(AFOSR-67-1865; AD-656782)

This report introduces the reader to the use of the quasilinearization technique which was developed by Bellman and Kalaba and applied extensively to chemical engineering problems by Lee in obtaining numerical solutions of certain classes of nonlinear ordinary differential equations of the boundary value type encountered in chemical engineering, optimization, the boundary layer theory, and in control problems. The nonlinear differential equation is first represented by a set of simultaneous first order differential equations. Each of the first order nonlinear differential equations is linearized using the Taylor series expansion with second and higher order terms omitted. Iterative solution of the resulting linear differential equations usually converges quadratically to the solution of the original equation. This means that each iteration approximately doubles the number of digits of accuracy. A simple problem of steady flow in the boundary layer along a cylinder near the forward stagnation point is solved to illustrate the use of the technique. TAB

N67-37644# Montana State Univ., Missoula. University Computer Center.
STABILITY BEHAVIOR OF DIFFERENTIAL EQUATIONS
John T. Clinker Jul. 1967 57 p refs
(TR-11)

The stability behavior of solutions of systems of differential equations is investigated. Conditions for stability, asymptotic stability, uniform stability and uniform asymptotic stability of linear systems are given in terms of fundamental matrices. The variation of constants formula is used to examine the stability behavior of certain nonlinear systems. Also the second method of Lyapunov and the concept of total stability are discussed. Several examples illustrating the theorems and applications are included. Author

N67-37681* Farnham (Frank C.) Co., Philadelphia, Pa.
DETERMINING THE EXTREMUM OF A MULTIPLE VARIABLE FUNCTION BY THE PARABOLIC APPROXIMATION METHOD [K OPREDELENIYU EKSTREMUMA FUNKTSII MNOGIKH PEREMENNYKH METODOM PARABOLICHESKOY APPROXSIMATSII]
G. I. Grezdov Washington, NASA, Sep. 1967 4 p ref Transl. into ENGLISH from the book "Matematicheskoye Modelirovaniye i Teoriya Elektricheskikh Tsepey" Kiev, Naukova Dumka, no. 3, 1965 p 170–171
(Contract NASw-1497)
(NASA-TT-F-11222) CSCL 12A

The parabolic approximation method is proposed for determining the extremum of a multiple variable function. The method is intended for use simultaneously with the methods of steepest descent or the gradient method. The result obtained coincides with the result of applying a linear approximation for a gradient. Author

N67-37705# Sud-Aviation, Paris (France).
INTRODUCTION TO SMOOTHING: APPROXIMATION [INTRODUCTION AU LISSAGE L'APPROXIMATION]
21 Sep. 1966 79 p In FRENCH
(Doc.-735, GTC/56) CFSTI: HC $3.00/MF $0.65

Earlier papers dealt with the problem of the reconstitution of a function x = f(t) on the basis of particular N values corresponding to exact values of the variable in the two extreme cases of knowledge, one of the function, the other of the errors. The intermediate cases are numerous and very varied. They can

be classified by taking as arguments: the quality of the variables (t exact and x an approximation or both t and x approximations), the degree of knowledge about the behavior of the errors (type of law, precision, or limits of the errors), the degree of knowledge about the function (type of representation, number of parameters, order, etc.). Although in practice nothing is ever known with exactness, either as regards the quality of the data or as regards the function, it is nonetheless of the greatest interest to take theoretical cases, not so much with a view to making rough calculations as to getting some idea of what possibilities exist of resolving the general problem. The present study deals with the putting into order of a limited number of data with the values of t being exactly known, and the data, of course, being raw, not converted. Author (ESRO)

N67-37723*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

AN ALGORITHM FOR THE DETERMINATION OF THE DEFINITENESS OF A REAL SQUARE MATRIX

Russell M. Hayes, Jr. 8 Aug. 1967 30 p refs

(NASA-TM-X-53644) CSCL 12A

An algorithm is described whereby the definiteness property of a real square matrix may be easily computed. The technique is based on well known theorems of matrix algebra which have been modified slightly to permit easy manual or machine computation. A FORTRAN program using the algorithm was written and was run on both the IBM 1130 and the SDS 930 digital computers. The computation time for a 7×7 matrix was approximately one second on the IBM 1130 and much less than one second on the SDS 930. Author

N67-37724# Massachusetts Inst. of Tech., Cambridge. Operations Research Center.

ALTERNATIVE SCHEMES FOR INVESTIGATING MARKOV DECISION PROCESSES

Amedeo Rodolfo Odoni Jun. 1967 74 p refs

(Contract DA-31-124-ARO(D)-209)

(DSR-79493; TR-28; AD-655893)

The report is concerned with the problem of finding optimal policies for infinite-horizon Markovian decision models. Several algorithms applicable to discrete time, discrete state, single-chain Markov processes with undiscounted rewards are described. One of these algorithms, called the iterative method with limits, is proved and its properties are discussed. The method consists of finding upper and lower limits for the optimal gain per transition of the infinite-horizon process. These limits improve on each iteration of the algorithm, and converge to the final value of the optimal gain, ultimately. Simultaneously, the algorithm produces the relative value variables, as well as the optimal policy. The computational efficiency of the aforementioned algorithms was compared by solving several test problems. It was found that for problems for which the number of alternatives per state is considerably less than the number of states, the iterative method with limits enjoys a serious speed advantage over the well-known policy iteration algorithms. The former method also produces very accurate results with very little programming effort. Author (TAB)

N67-37857# Massachusetts Inst. of Tech., Cambridge. Operations Research Center.

SHORTEST ROUTE METHODS FOR FINITE STATE SPACE, DETERMINISTIC DYNAMIC PROGRAMMING PROBLEMS

Jeremy F. Shapiro Jul. 1967 76 p refs

(Contract DA-31-124-ARO(D)-209)

(AROD-968.46-M; TR-31; DSR-75217; AD-656812)

A general finite state space, deterministic dynamic programming model with either a finite or infinite planning horizon is viewed as a network optimization problem. Optimal strategies for the model are characterized by optimal (minimal discounted or average cost) paths in the network. Shortest route type algorithms are constructed which find optimal paths of infinite length. Shortest route methods are also exploited in reducing the work of backward iteration in finding optimal paths of finite length. More important, however, is the fact that for finite planning horizons of sufficient length, any optimal immediate decision must also be an immediate decision that is optimal when faced with an infinite horizon. Thus, in the sense of selecting an optimal immediate decision, successive approximation of an optimal infinite horizon strategy by optimal finite horizon strategies exhibits finite convergence. Upper bounds on how long a time horizon is sufficiently long for the convergences to occur are developed. In addition, tests are given for detecting when this convergence of the backward iterative procedure has been effected. Finally, results on the form of optimal paths of any length are given. Author (TAB)

N67-37858# California Univ., Berkeley. Operations Research Center.

CYCLES WITH MINIMUM AVERAGE LENGTH

Alain Fillières Jun. 1967 22 p refs

(Contract DA-31-124-ARO(D)-331)

(ORC-67-21; AROD-5307.24-M; AD-656471)

Given a directed network whose arcs have lengths unrestricted in sign and which contains at least one cycle, an algorithm to find the minimum average length cycle (length divided by its number of arcs) is described. A direct application of this algorithm solves the problem of finding whether a directed graph contains a cycle with negative length. Author (TAB)

N67-37972# Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center.

SAMPLING MOMENTS OF MOMENT AND MAXIMUM LIKELIHOOD ESTIMATORS FOR DISCRETE DISTRIBUTIONS

L. R. Shenton, K. O. Bowman, and Juris Reinfelds (Ga. Univ.) [1967] 43 p Prepared Jointly with Ga. Univ.

(Contract W-7405-ENG-26)

(K-DP-2413) CFSTI: HC $3.00/MF $0.65

A generalized recursive formula is given for the expectation of a certain product of powers of orthogonal statistics. This includes a recursive scheme, suitable for a digital machine, for the expectation of products of powers of crude sample moments. The result is useful in studying the distributional properties of moment estimators and generalized moment estimators. NSA

N67-37988# Sud-Aviation, Cannes (France). Groupe Technique.

INTRODUCTION TO SMOOTHING: THEORETICAL INTERPOLATION [INTRODUCTION AU LISSAGE: L'INTERPOLATION THEORIQUE]

21 Mar. 1966 72 p In FRENCH

(Doc.-732-GTC/55) CFSTI: HC $3.00/MF $0.65

The problem of exploiting measurements, of which smoothing is only a particular aspect, bears on a variable value (a function) on the one hand, and on errors on the other. To solve it completely would mean not only reconstituting the function (and therefore each individual error), but also reconstituting the law of errors. The paper deals with the case of maximum knowledge of the errors, which brings one back to the case of precise data: this is theoretical interpolation. Author (ESRO)

N67-38046# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

ON INTEGRAL TRANSFORMATION CONNECTED WITH THE KLEIN–GORDON EQUATION [OB INTEGRAL'NYKH PREOBRAZOVANIYAKH, SVYAZANNYKH S URAVNENIEM KLEINA–GORDONA]

Ya. A. Smorodinskii and E. L. Surkov 1967 11 p refs In RUSSIAN
(JINR-P2-3323)

Integral transformations are obtained which transform the functions on the cone $k^2=0$ into the solutions of the Klein–Gordon equation $(p^2-m^2)\phi(x)=0$ and inversely. The wave functions $\phi(x)$ are expanded into irreducible components under the Lorentz group in different frame of references. Integral transformations connecting the hyperboloid $p^2=1$ with the solutions of the d'Alembert equations are presented. Author (NSA)

N67-38056 Montana State Univ., Missoula. Computer Center.
THE METHOD OF STEEPEST DESCENT
James S. Lucke Aug. 1967 63 p refs
(TR-12)

The philosophy of the method of steepest descent is analyzed and applications of the method to systems of linear equations are discussed. Vector analysis and linear algebra concepts are also reviewed. S.C.W.

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N67-36748# Air Force Cambridge Research Labs., Bedford, Mass.
A STATISTICAL MODEL OF THE TEMPERATURE FIELD AT SUPERSONIC AIRCRAFT ALTITUDES Interim Scientific Report
Irving I. Gringorten May 1967 53 p refs /ts AF Surv. in Geophys. No. 193
(AFCRL-67-0274; AD-656309)

Data archives are such that, for a selected cruising level, a reasonably large sample of daily average temperatures along a specific route can be obtained and summarized into a frequency distribution. But if, as in Air Force operations, many different and constantly changing routes are involved, then the climatologic tools and methods must be such as to provide estimates of the route average temperature without recourse to the archives and the processing of raw data. A method was devised that utilizes a model of the horizontal spatial correlations of temperature. It was demonstrated on a continent-wide area, and shows promise of hemisphere-wide application. Author (TAB)

N67-36812# Army Electronics Labs., Fort Monmouth, N. J. Atmospheric Sciences Lab.
BOUNDARY-LAYER METEOROLOGY AS DERIVED FROM REDUCTION OF THE FRIGORIMETER DATA PART II, POLAR ZONES
E. C. Taylor-Ellis Apr. 1967 34 p refs
(ECOM-2825; AD-656604)

The report reviews 84 months of Frigorimeter data measured in Arctic and Antarctic environments. The rationale underlying the development of the black-body sensor of the Frigorimeter is summarized, and the climatology of eight polar sites is illustrated. Conclusions are drawn which attest the ruggedness and the pragmatic usefulness of the Frigorimeter as a meteorological tool. Author (TAB)

N67-36833# Emmanuel Coll., Boston, Mass. Oriental Science Library.
MARKOV PROCESS IN THE CONTINUOUS GROWTH OF CLOUD DROPS UNDER CONDITIONS OF SMALL-SCALE FLUCTUATIONS AND ITS EFFECT ON THE DEVELOPMENT OF CUMULONIMBUS
Qing-fang Xu, Gui-chen Li, and Jing-song Wen Bedford Mass., AFCRL, Jun. 1967 19 p refs Transl. into ENGLISH from Ch'i Hsiang Hsueh Pao (Peking), v. 36, no. 2, Jun. 1966 p 243–248
(Contract AF 19(628)-5073)
(EMM-67-155; AD-655368)

When the scale of fluctuation is relatively small, the continuous stochastic growth of cloud droplets may be treated as a diffusion problem in an R-space where R denotes the drop radius. Not only is the influence of this type of fluctuation very pronounced in warm cumulus, but is also significant in cumulonimbus containing ice crystals. Observational evidence has already shown that during the development of cumulonimbus in middle latitudes, a large number of precipitation elements has already formed in the warm cloud stage often before the onset of crystallization. For such large drops, the average rate of growth is greater by coalescence than by the ice-crystal process. Consequently, the appearance of ice crystals at the later stage and the associated process of sublimation-condensation transfer may not be so important. TAB

N67-36873# Danish Meteorological Inst., Charlottenlund.
SUMMARIES OF WEATHER OBSERVATIONS AT WEATHER STATIONS IN GREENLAND, 1951–1960
1967 215 p

Tables are presented of the synoptic surface observations. The data includes concurrent wind speed and wind direction occurrences, surface wind frequencies, simultaneous occurrences of visibility ranges and ranges of cloud base, and fog, precipitation, and drifting snow frequencies. N.E.N.

N67-37012*# Army Missile Command, Huntsville, Ala. Physical Sciences Lab.
WIND PROFILE CLIMATOLOGY OF NEW ORLEANS, LOUISIANA
O. M. Essenwanger and G. H. R. Reisig (Marshall Space Flight Center) 2 May 1967 53 p refs
(NASA Order H-61485)
(NASA-CR-88803; RR-TR-67-8; AD-655582) CSCL 04B

The prominent climatological features of the tropospheric wind field at New Orleans, Louisiana, have been analyzed in terms of wind direction and wind speed. For the purpose of appraising the physical properties of the acoustical far field at the Mississippi Test Facility within the adjacent environment of New Orleans, the directional parameter of the wind field was investigated in particular depth. Besides the mean profiles of wind direction, the mode profiles were derived by means of a new method developed by Dr. Essenwanger, which is presented in an appendix to the report. Both the wind direction profiles, in terms of mean and mode, and the mean scalar wind speed profiles are presented for the whole year, the four seasons, and the individual months. Also, the annual profiles of various time periods of the day are provided for both wind direction and wind speed. TAB

N67-37035# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
A DIABATIC SURFACE BOUNDARY LAYER MODEL
Frank V. Hansen Jul. 1967 171 p refs
(ECOM-5138; AD-656739)

A diabatic surface boundary layer model valid for stationary, homogeneous conditions in stable and unstable air is developed from dynamic similarity of flows concept as applied to the lower

portion of the atmosphere. The model is a development of the basic similarity theory of Monin and Obukhov and utilizes concepts advocated by McVehil, Panofsky and Pandolfo. It was found that a critical value of the gradient Richardson number exists at Ri = 0.223 and that the vertical gradients of wind and temperature are inversely proportional to height, to a negative power of the exchange coefficient ratio. The model is presented in tabular form over the stability range 0.220 > Ri > -5.00. Author (TAB)

N67-37247# National Severe Storms Lab., Norman, Okla. Inst. for Environmental Research.
ON THE CONTINUITY OF WATER SUBSTANCE
Edwin Kessler Apr. 1967 141 p refs
(IERTM-NSSL 33)

Several kinematic models of microphysical processes occurring in the atmosphere are presented. Relations among distributions of air motion, precipitation, clouds, and vapor are discussed. Continuity equations for the models are derived and discussed; and applied to a variety of sample situations. A model of the onset of precipitation from an infinite uniform cloud is presented. The gravitational separation of raindrops of different sizes is also discussed; and an interpretation of radar weather data (with respect to altitude) based on the theory discussed is given. L.S.

N67-37248 International Geophysical Year World Data Center A, Asheville, N. C.
METEOROLOGICAL ROCKET NETWORK FIRINGS, VOLUME III, NUMBER 11 Data Report
Nov. 1966 215 p
GPO: $3.00

Wind and temperature data measurements from all available meteorological sounding rocket firings for November, 1966 are presented in tables and graphs. Computed values for pressure, density, and speed of sound are given; and the local radiosonde observations nearest the time of firing are included. L.S.

N67-37281# RAND Corp., Santa Monica, Calif.
COMPUTERIZED CLIMATOLOGY VS. SATELLITE RECONNAISSANCE IN A MINIMUM CLOUD AREA
C. Schutz Jul. 1967 40 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5365-PR; AD-655347)

Air masses, weather systems, and related flow patterns, along with their seasonal variations, influence cloud cover, and the degradation to satellite surveillance of the earth is thereby affected. A new computer product, developed from representative local observations of clouds, is used to show how these weather variables, even in the semiarid-to-subtropical region of the intermontane states, make 100 percent cloud-free line of sight from a satellite impossible. Author (TAB)

N67-37344# Chicago Univ., Ill. Dept. of the Geophysical Sciences.
CLOUD PHYSICS LABORATORY—COLLECTION OF REPRINTS XI
15 Aug. 1967 80 p refs Sponsored by NSF
(TN-38)

Reprints of publications on cloud physics are presented, including papers presented at American Meteorological Society meetings. Meteorological fluctuations in clouds are discussed, as is cirrus cloud seeding as a trigger for the development of storms. Evaporation of raindrops in the presence of vertical gradients of temperature and relative humidity is reported, along with papers on ures as an ice nucleant for supercooled clouds, natural ice crystals that have uncommon shapes, and the giant sea-salt particles in the atmosphere over the world ocean. Other papers are on the energy spectra of cloudy air, cirrus heights and temperatures over the central part of the United States, and the depths and temperatures of continental convective clouds during the initial precipitation echo. M.W.R.

N67-37368# Emmanuel Coll., Boston, Mass. Oriental Science Library.
A CLOUD-DROPLET SAMPLER FOR CONTINUOUS OPERATION AT GROUND LEVEL
Mei-yuan Huang, Chung-hsiang Hung, and Shang-ching Haiung Bedford, Mass., AFCRL, Jun. 1967 13 p refs Transl. into ENGLISH from Ch'i Hsiang Hsueh Pao (Peking), v. 30, no. 2, May 1965 p 257–262
(Contract AF 19(628)-5073)
(EMM-67-154; TT-67-62361; AD-655367)

This paper describes the design and construction of a cloud-droplet sampler for continuous operation at ground level. The equipment used previously can only work continuously for two seconds in a single probing, while in this one the duration of continuous sampling may be extended up to two minutes with an adjustable exposure control. Field experiments carried out in the spring of 1964 show that this instrument can be used to scan the fluctuations of parameters characterizing the microstructure of cloud and fog with periods of the order of 0.1 to 10 seconds. A simple assessment of the instrumental error has also been made. Author (TAB)

N67-37474# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
ON TIME VARIABILITY OF WIND AT WHITE SANDS MISSILE RANGE, NEW MEXICO
Laurence J. Rider Jun. 1967 24 p refs
(ECOM-5130; AD-656605)

Records of cinetheodolite balloon observations at White Sands Missile Range, New Mexico (WSMR) to 8000 feet above the surface have been analyzed in sets of 11- and 20-minute intervals to determine the magnitude of horizontal wind vector changes. The means of the magnitude for the horizontal wind vector changes varied from 1.8 to 2.8 ft/sec for time intervals of 11 and 20 minutes. The means of the horizontal wind direction change over the same time intervals varied from 7 to 34 degrees. The greatest variability occurred in layers below 3000 feet. Author (TAB)

N67-37554*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
STRATOSPHERIC TEMPERATURE PATTERNS DERIVED FROM NIMBUS II MEASUREMENTS
Guenter Warnecke and Andrew W. McCulloch Aug. 1967 18 p refs Presented at the COSPAR 10th Plenary Meeting, London, 24–29 Jul. 1967
(NASA-TM-X-55921; X-622-67-436) CFSTI: HC $3.00/MF $0.65 CSCL 04B

The Nimbus II medium resolution infrared radiometer (MRIR) experiment provided data for the period of May 15 to July 29, 1966. The measurements within the 15 micron carbon dioxide absorption band were processed by a large computer and printed in map form as polar stereographic and Mercator projections. The influence on the measurements by middle and upper tropospheric cloud systems was eliminated by automatic application of a specific correction model using the simultaneous measurements of the 10–11 micron window channel for the needed cloud top height information. The series of horizontal stratospheric temperature patterns that can be derived from these measurements covers the northern hemisphere in late spring and early summer as well as the southern hemisphere in late fall and early winter seasons. Author

N67-37984 International Geophysical Year World Data Center A, Asheville, N. C.
METEOROLOGICAL ROCKET NETWORK FIRINGS, VOLUME III, NUMBER 12 Data Report
Dec. 1966 195 p

The report contains the wind and temperature measurements from all available meteorological sounding rocket firings for December 1966 and, in addition, computed values for pressure, density, and speed of sound. It also includes the local radiosonde observations nearest the time of firing, with release time of the radiosonde within ±6 hours of the time of firing. However, exceptions up to ±12 hours are made, particularly in tropical regions. Only successful firings, i.e., those yielding significant data, are listed. A brief monthly summary designed to compare the mean profile for the current month with long-term means for the same month is included. Also listed are the 31 Meteorological Rocket Network Stations which contributed the data, the rocket types that were used, and the wind and temperature sensors used to obtain the data. K.W.

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N67-36869# Parametrics, Inc., Waltham, Mass.
RADIOISOTOPE TAXI GUIDANCE SYSTEM. PHASE II: FABRICATION AND INSTALLATION Final Report
B. Sellers and J. Hunerwadel Mar. 1967 40 p
(Contract FA-65-WA-1334)
(RD-67-35) CFSTI: HC$3.00/MF$0.65

An experimental model of the radioisotope zero visibility taxi guidance system was fabricated, lab tested, and installed at the FAA National Aviation Facilities Experimental Center. Some difficulties were encountered in placing the gas handling system in operation, principally as a result of the necessity of using plastic rather than copper pipe. The final tests carried out in an aircraft under simulated zero visibility conditions demonstrated that the entire system is operationally feasible, and that the FAA design goals can either be achieved or closely approached. Author

N67-37180*# General Motors Corp., Milwaukee, Wis. AC Electronics Div.
INTERPLANETARY GUIDANCE SYSTEM REQUIREMENTS STUDY, VOLUME I Final Report
Apr. 1967 433 p refs
(Contract NAS12-7)
(NASA-CR-80018) CSCL 17G

Performance assessment tradeoff studies are discussed in terms of missions and system configurations. The mathematical model used in developing digital computer programs for the aided-inertial space guidance systems is described, and details are given on the different mission phases. Powered flight, free fall, and reentry are considered for space missions using conventional high-level chemical propulsion. The model used for low-thrust space missions is also described. The numerical data associated with assessing navigation and guidance systems for midcourse phases and for atmospheric entry, powered flight, and trajectories and system configurations are included. The findings on the state-of-the-art technology indicate: (1) Navigation performance levels appear adequate for all mission phases except preentry approach to a distant planet (Mars). (2) Inertial systems are not sufficiently accurate for unaided inertial guidance of skipout reentry. (3) Onboard electromagnetic sensors are inadequate for interplanetary midcourse phases leading directly to atmospheric entry. M.G.J.

N67-37228# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
BASIS OF INERTIAL NAVIGATION
A. A. Yakushenkov 4 May 1967 159 p refs Transl. into ENGLISH of the book "Osnovy Inertsial'noy Navigatsii" Moscow, Izdatel'stvo Morskoy Transport, 1963 p 1–146
(FTD-MT-65-189; AD-656562)

The work expounds the bases of the theory of inertial systems designed for naval navigation, the principle of action of their component elements and questions of long-term development of inertial navigation for the naval fleet. As the basis of the book there are the somewhat expanded and consideration is given to the kinematics of systems of inertial navigation, oriented in certain coordinate systems, which are of interest for the naval fleet, composed of block diagrams of inertial reference-points in these coordinate systems; also considered are certain specific errors of naval inertial systems, and principles are presented of automatic pilotage using inertial systems. TAB

N67-37502# Lockheed-Georgia Co., Marietta.
DEVELOPMENT OF ALL WEATHER LANDING SYSTEM RELIABILITY ANALYSIS AND CRITERIA FOR CATEGORY III AIRBORNE SYSTEMS, PHASE III. VOLUME II: APPENDICES
L. A. Atkins, J. D. St. Clair, M. C. Thatro, and H. R. Willis May 1967 103 p refs
(Contract FA-65-WA-1376)
(ER-8957, Vol. 2; SRDS-RD-67-20, Vol. 2: AD-655241) CFSTI: HC$3.00/MF$0.65

The primary program effort was directed toward a quantitative evaluation of reliability, availability, safety and human factors for airborne systems. Since a number of considerations associated with Category III landing problems presently defy quantification, an appendix has been developed to investigate in general these considerations. The reliability analysis presented in Volume I has required a large and varied number of calculations. Appendices have been developed to present examples of the manner in which these calculations were effected. Also presented is a discussion of a proposed two channel system exhibiting a fail operative capability, which is contrary to the fail passive characteristics of a two channel system assumed in Volume I. During this program, a considerable amount of research was conducted to provide a basis for the development of a quantiative human error prediction procedure. The results of this research is presented in appendices covering general human factors considerations associated with Category III systems and an analysis of accident data which was conducted to investigate human error characteristics of aircraft accidents. TAB

N67-37544# Parametrics, Inc., Waltham, Mass.
RADIOISOTOPE TAXI GUIDANCE SYSTEM. PHASE I: FEASIBILITY STUDY Final Report
B. Sellers, J. Hunerwadel, and C. Ziegler Mar. 1967 73 p ref
(Contract FA-65-WA-1334)
(RD-67-18)

Methods utilizing radioisotopes as an integral part of an all weather, zero visibility, ground guidance system have been evaluated. The most promising technique has been selected and examined in detail both theoretically and experimentally and a system design is presented. The method employs a stationary avionic gamma ray detector enclosed by a rotating collimator, which senses the position of the aircraft relative to a radioisotopic line source of radiation buried beneath the runway centerline. The avionic

unit, approximately one cubic foot in volume, can be mounted in the interior of the aircraft and no structural modifications of the aircraft are required. The information displayed for the pilot is the position of the aircraft relative to the centerline, with an accuracy of better than ± 5 feet at the centerline. The standard radarscope can be used as a display. A key feature of the system is that it uses a chemically inert radioactive gas, krypton-85, which is deployed in the pipe laid in the runway. When not in use the gas can be removed from the runway using conventional gas handling and pumping apparatus. Radiation safety aspects of an operational system have been examined and found to present no hazard beyond normal industrial practice. An additional feature of the radioisotope system is that it can form the basis of an aircraft location and ground control system. The estimated total installation cost of the ground guidance system in a typical airport (Dulles) is about $41,000. The avionic units will cost between $2,300 and $3,300. It was recommended that an experimental model of this system be constructed and field tested. Author

N67-38002*# Michigan Univ., Ann Arbor. Inst. of Science and Technology.
SATELLITE NAVIGATION STUDIES Quarterly Progress Report, 1 Apr.–30 Jun. 1967
Y. Morita, F. Zwas, and D. Colling Aug. 1967 14 p
(Contract NASr-54(10))
(NASA-CR-88871; QPR-6) CFSTI: HC $3.00/MF $0.65 CSCL 17G

Efforts centered on determining aircraft positional fixes using the VHF channels on the currently operational satellite ATS-1 and the soon-to-be launched satellite ATS-C. The digital computer model is being modified to include VHF propagation effects, and the model will be used to predict expected aircraft position fixes. In addition, equipment characteristics for use aboard aircraft are being delineated. Author

N67-38039# Royal Aircraft Establishment, Farnborough (England).
AN AUTOMATIC ATTITUDE CONTROL SYSTEM FOR A SPINNING SATELLITE: A THEORETICAL ASSESSMENT
A. J. Sarnecki Nov. 1966 19 p
(RAE-TR-66368) CFSTI: HC $3.00/MF $0.65

A method is described by which a spinning satellite may maintain its spin axis normal to the orbit without the need for a ground-to-satellite command link. The proposal control system uses earth sensors, on-board logic and a jet system to provide the control torques. The report could form the basis of an engineering design of a system capable of accuracy within a fraction of a degree. Author (ESRO)

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N67-38713*# Oak Ridge National Lab., Tenn.
BRAYTON-CYCLE RADIOISOTOPE HEAT-SOURCE DESIGN STUDY. PHASE II (PRELIMINARY DESIGN) REPORT
R. A. Robinson, T. G. Chapman, S. T. Ewing, A. J. Miller, and J. P. Nichols Aug. 1967 140 p refs
(NASA Order C-64217-A; W-7405-ENG-26)
(NASA-CR-72151; ORNL-TM-1829) CFSTI: HC $3.00/MF $0.65 CSCL 18N

A preliminary design was prepared for a 25-kw(th) $^{238}PuO_2$ heat source that can be coupled with a Brayton-cycle power-conversion system for use in space. Primary containment is provided by multilayered fuel capsules, with tantalum-based alloy T-111 as the principal stress-bearing layer and platinum as the outer corrosion-resistant layer. The multipurpose mission module is used as the vehicle configuration for integration studies. The assembly of fuel capsules is contained within a single reentry body for protection against reentry heating and subsequent impact in the event of a mission abort. The fuel capsule complies with the design criterion of no more than 1% creep in five years of service. The safety guideline that the radioisotope fuel can be contained within the fuel capsules for a period of ten half-lives of ^{238}Pu or longer is a goal toward which the capsule design is directed. The weight of the heat-source system, including the reentry body, fuel, heat exchanger, shield, etc., is 2670 lb. Preliminary designs are described of facilities for fueling and assembling capsules, shipment of capsules to launch site, and handling at the launch site. Since the heat-source design is based partly on near-future materials technology and on extrapolation from present aerodynamic data, identification is made of areas where further investigations will have to be carried out to test the validity of the design. Author

N67-38876*# Oak Ridge National Lab., Tenn.
BRAYTON-CYCLE RADIOISOTOPE HEAT SOURCE DESIGN STUDY. PHASE I: (CONCEPTUAL DESIGN) REPORT
R. A. Robinson, R. J. Beaver, D. W. Burton, T. G. Chapman, C. W. Craven, Jr., et al Aug. 1967 239 p refs Sponsored by NASA
(Contract W-7405-ENG-26)
(NASA-CR-72090; ORNL-TM-1691) CFSTI: HC $3.00/MF $0.65 CSCL 18N

Conceptual designs were prepared for $^{238}PuO_2$, $^{244}Cm_2O_3$, and $^{147}Pm_2O_3$ radioisotope heat source systems that will provide 25 kW of thermal power to a Brayton cycle power conversion system for space applications. The conceptual designs for all three fuels show primary containment provided by multilayered fuel capsules, with tantalum-based alloy T-222 as the principal stress bearing layer and platinum as the outer corrosion resistant layer. All the designs show the assembly of fuel capsules contained within a single reentry body for protection against reentry heating and subsequent impact in the event of a mission abort. The designs are based on containing the radioisotope fuel within the fuel capsules for a period of time equal to ten half-lives or longer of the radioisotope. Estimated system weights based on the conceptual designs range from approximately 3,000 to 25,000 lb, depending on the fuel and design concept. Author

N67-38957# Institut za Nuklearne Nauke (Boris Kidric), Belgrade (Yugoslavia).
A STANDARD GRAPHITE BLOCK
Magdalena Ivkovic, Zoran Zdravkovic, and Obrad Sotic *In its* Bull. of the Boris Kidric Inst. of Nucl. Sci., Vol. 17, No. 2 1966 p 97–112 refs (See N67-38954 22-34)

A graphite block was calibrated for the thermal neutron flux of the Ra–Be source using indium foils as detectors. Experimental values of the thermal neutron flux along the central vertical axis of the system were corrected for the self-shielding effect and depression of flux in the detector. The experimental values obtained were compared with the values calculated on the basis of solving the conservation neutron equation by the continuous slowing down theory. In this theoretical calculation of the flux the Ra–Be source was divided into three resonance energy regions. The measurement

of the thermal neutron diffusion length in the standard graphite block is described. The measurements were performed in the thermal neutron region of the system. The experimental results were interpreted by the diffusion theory for point thermal neutron source in the finite system. Author

N67-37042# Atomics International, Canoga Park, Calif.
ANALYSIS OF SNAPTRAN-3 DESTRUCTIVE EXPERIMENT
W. A. Rhoades 31 Mar. 1967 5 p refs
(Contract AT(04-3)-701)
(NAA-SR-9780 (ADDEND 1)) CFSTI: HC $3.00/MF $0.65

It is reported that modern cross section data incorporating coefficient effects was used to determine the theoretical SNAPTRAN-3 temperature coefficient of reactivity. The calculations were performed with a spatially dependent kinetics code that included spatial importance distribution effects, as well as spatially dependent calculations of flux, power density, temperature, and feedback effects. The coefficient was found to have a somewhat smaller long period value than was previously calculated. It is concluded that the experimentally determined coefficient was not anomalous in a physical sense, and that it is only necessary to do a proper spatially dependent kinetics calculation with accepted cross section data to arrive at agreement between theory and experiment. C.T.C.

N67-37069# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
MEASUREMENTS OF THE FISSION PRODUCT GAS PRESSURES DEVELOPED IN UO_2 FUEL ELEMENTS DURING OPERATION
M. J. F. Notley, R. Dashaies, and J. R. MacEwan Nov. 1966 78 p refs
(AECL-2662) Available from Atomic Energy of Canada, Ltd., Chalk River: $2.00

An experimental irradiation is described in which the gas pressures developed inside 12 operating UO_2 fuel elements were measured at intervals during irradiation. Results are presented of the effect of heat rating and fuel density on fission product gas release and pressure. A significant proportion of the fission product gas in the fuel was found to be released during reactor power transients, although over the whole irradiation the amount of gas released was approximately proportional to the burnup. Most of the release occurred as the element power was lowered. The dependence of gas pressure on element power during the first startup was similar to that predicted using a simple model for fuel behavior; the sintered fuel pellet was considered to crack and deform under the stresses resulting from the fuel thermal expansion. Subsequently, when the expansions of a cracked, deformed pellet govern the gas pressure, the pressure was observed to vary linearly with power output. A decrease in fuel density was found to increase the amount of fission product gas released. Author

N67-37103# Atomic Energy Commission Research Establishment, Lucas Heights (Australia).
A BRIEF SURVEY OF PROCESSES FOR HEAVY WATER PRODUCTION
R. K. Ryan Feb. 1967 24 p refs
(AAEC/TM368)

A brief review is given of methods for the production of nuclear grade heavy water, including water electrolysis, distillation, and chemical exchange processes. Present world production comes mainly from the U.S.A., however Canadian plants will shortly produce much of the world supply. These plants use the H_2O/H_2S process, the only one developed to industrial scale. Sufficient development of the NH_3/H_2 process has proceeded for its use industrially. Heavy water production as a by-product of established industries appears attractive provided a process matched to the feed supply is available. There are many possible processes that have not been developed. Author

N67-37108# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
CONVECTION HEAT TRANSFER IN MOLTEN CENTER OXIDE FUELS
J. A. Christensen Jun. 1967 28 p
(Contract AT(45-1)-1830)
(BNWL-418) CFSTI: HC $3.00/MF $0.65

Upward displacement of the molten zone in horizontally irradiated UO_2 fuel rods was observed and attributed to convection heat transfer in the liquid oxide. The displacement was correlated with the size of the molten zone through a derived virtual film coefficient for the $UO_2(s)$–$UO_2(l)$ interface. Results were also analyzed in terms of melt diameter and a dimensionless parameter which combines effects of molten zone size, volumetric fission rate, and fuel melting point. Practical implications of the results include the possibility that departure from verticality in a molten-center fuel may cause fuel rod warping because of an upward thermal skew resulting from convection heat transfer in the liquid portion of the fuel. Author (NSA)

N67-37211# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
SAVANNAH RIVER LABORATORY ISOTOPIC POWER AND HEAT SOURCES, PART 1: COBALT-60 Quarterly Progress Report, Jan.–Mar. 1967
H. S. Hilborn, comp. May 1967 19 p refs
(Contract AT(07-2)-1)
(DP-1105-I) CFSTI: HC $3.00/MF $0.65

About 9 million curies of ^{60}Co (140 kilowatts) at an average of 400 curies per gram of metal (55 watts/cm^3) will be discharged from the reactor during the next quarter. 5,000- and 10,000-hour heating tests of capsules of radioactive cobalt metal contained in "Inconel" 600 were begun at 850°C in air. An "Inconel" 600 capsule with a 0.050-inch-thick wall that reached a temperature of 1100°C for 3 to 6 hours swelled but did not leak. Author (NSA)

N67-37216 Joint Publications Research Service, Washington, D. C.
THREE-DIMENSIONAL CALCULATION OF FUEL BURN-UP IN WATER-COOLED, WATER-MODERATED POWER REACTORS
A. N. Novikov, D. M. Petrunin et al 11 Sep. 1967 21 p refs
Transl. into ENGLISH of the Meeting on Fuel Burn-up Predictions in Thermal Reactors held in Vienna, 10–14 Apr. 1967
(JPRS-42542; TT-67-33170) CFSTI: $3.00

Methods for accurately calculating reactor fuel burnup are considered. Basic design elements of a water cooled, water moderated reactor are given along with descriptions of two-dimensional and Three-dimensional theoretical calculations. Comparisons are made based on experimental observations. E.C.

N67-37231# Los Alamos Scientific Lab., N. Mex.
METALLOGRAPHY OF PYROLYTIC CARBON-COATED AND/OR TUNGSTEN-COATED URANIUM OXIDE AND URANIUM CARBIDE FUEL SPHERES
J. H. Bender [1967] 8 p
(Contract W-7405-ENG-36)
(LA-DC-8676; CONF-670533-2) CFSTI: HC $3.00/MF $0.65

Procedures for the metallographic preparation of pyrolytic C- and/or W-coated UO_2 and UC fuel spheres are described. These include mounting, grinding, polishing, and etching techniques for optical and electron microscopy. Author (NSA)

N67-37232# Minnesota Mining and Mfg. Co., St. Paul, Minn. Isotope Power Lab.
SNAP-21 PROGRAM, PHASE II: DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM Quarterly Report, 20 Jun.–30 Sep. 1966
R. Wickenberg 21 Oct. 1966 129 p refs
(Contract AT(30-1)-3691)
(MMM-3691-6; QR-1) CFSTI: HC$3.00/MF$0.65

Progress is reported on the deep sea ^{90}Sr fueled thermoelectric generator (SNAP-21) power supply system. In the design, development, and fabrication of a thermal insulation system, the neck tube and structural support member for the biological shield were designed and analyzed. Design effort was initiated on the overall 10 W system and components. Tests on thermal insulation inner liner, biological shield, and shield to liner bolts are reported. Conceptual design of the 20 W system was also initiated. A biological shield used previously was refurbished. A copper flame spray process was developed for the inner liner. Additional performance data for the 721 Ti alloy used in the pressure vessel were obtained. NSA

N67-37313# Battelle Memorial Inst., Columbus, Ohio.
PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JANUARY THROUGH MARCH, 1967
Donald L. Keller 1 Apr. 1967 98 p ref
(Contract W-7405-ENG-92)
(BMI-1798) CFSTI: HC$3.00/MF$0.65

Developments are reported for studies on: UN–PuN fuels for LMFBR applications; radiation effects on reactor cladding materials; coated-particle fuel materials; ceramic-coated Pu-base particle fuels; graphite coatings on fuel particles; UO_2–PuO_2 fuel development; and effects of high burnup on UO_2–CeO_2 and UO_2–ZrO_2 fuels. NSA

N67-37323# Naval Research Lab., Washington, D. C. Metallurgy Div.
IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS Quarterly Progress Report, 1 Feb.–30 Apr. 1967
J. R. Hawthorne, C. Z. Serpan, Jr., H. E. Watson, and R. A. Gray, Jr. 15 May 1967 62 p refs
(NRL-MEMO-1780; AD-656578)

The report includes the following: (1) a comparison of the response of selected structural steels to irradiation at 550 and 650F to high neutron fluences, (2) the through-thickness Charpy-V notch ductility performance of a 10-1/2-in.-thick plate of irradiated A302-B steel, (3) an investigation of the effects of oxygen and nitrogen contents on the radiation embrittlement sensitivity of 7-1/2Ni-Cr-Mo steel at 250F, (4) the notch ductility behavior of irradiated 12Ni-5Cr-3Mo maraging steel weldments, (5) the response of A350-LF1 (Modified) steel to postirradiation annealing at temperatures in the range of 550 to 590F, (6) the notch ductility behavior of A350-LF1 (Modified) steel with cyclic 430F irradiation-168 hour annealing, (7) the preirradiation mechanical properties of the MH-1A reactor pressure vessel steel, (8) the notch ductility of several reactor structural steels after irradiation in a heavy water moderated reactor, (9) the modification, installation, and initial operation of a remotely operated, tape-controlled milling machine, and (10) a description of newly acquired remotely operated precision measuring equipment. Author (TAB)

N67-37333# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
METHODS IN USE AT D.E.R.E. FOR THE MEASUREMENT OF BURN-UP OF NUCLEAR FUELS AND NEUTRON DOSE
W. R. Diggle, A. J. Gaunt, K. R. Melhuish, and E. E. Newman 17 Apr. 1967 37 p refs
(TRG-1494(D)) HMSO: 5s

The methods for both burn-up and neutron dose measurement are described, and the relevant calculations and nuclear data used are given. Methods include: measurement of changes in isotopic composition of fuel, measurement of radioactive and stable fission products, and the use of flux monitors. The limitation and accuracy of each method is discussed. Author

N67-37363# Oak Ridge National Lab., Tenn.
MSRE CONTROL ELEMENTS: MANUFACTURE, INSPECTION, DRAWINGS, AND SPECIFICATIONS
G. M. Tolson and A. Taboada Jul. 1967 53 p refs
(Contract W-7405-ENG-26)
(ORNL-4123) CFSTI: HC$3.00/MF$0.65

The control elements for the Molten Salt Reactor are Gd_2O_3–Al_2O_3 bushings canned in Inconel. The report includes material selection and development of fabrication methods. The can was made from fully inspected Inconel closed by four TIG welds. The Gd_2O_3–Al_2O_3 bushings were made by conventional pressing and sintering methods after a special prereaction step was used. The bushings were given thermal shock tests, weighed, dimensionally inspected, and given a final visual inspection for chips or cracks. As-built drawings, specifications, and manufacturing procedures are included. By methods described in this report, 160 MSRE control rod elements were manufactured. Author (NSA)

N67-37378# Minnesota Mining and Mfg. Co., St. Paul Minn.
SNAP-21 PROGRAM, PHASE II: DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM Quarterly Report, Jan. 1–Mar. 31, 1967
J. F. X. Weinig May 1967 142 p ref
(Contract AT(30-1)3691)
(MMM-3691-17; QR-3) CFSTI: HC$3.00/MF$0.65

The SNAP-21 system design and trade-off study to investigate possible means of improving system performance is described. Other significant accomplishments discussed include: fuel capsule weld development; ultrasonic weld testing; biological shield plug design; wrapping of the SNAP-21 residual phase I insulation system; and the selection of three tension tie rods and a neck tube as the biological shield support system. Insulation system offgassing tests and vacuum sealoff and getter retention tests were continued. The segmented retaining ring design was analyzed and a design change prepared. Seven pressure vessel materials were examined, and a material (Ti 621.8) was selected. The design for the second three development generators (in-line concept) was initiated. Generator test equipment design parameters were established. Cold and heat transfer tests 4 through 15 were completed. Thermoelectric leg inspection testing was initiated. Radiation testing arrangements of the SNAP-21 biological shield in the insulation system were completed. NSA

N67-37418# Minnesota Mining and Mfg. Co., St. Paul, Minn. Isotope Power Products.
SNAP-23A PROGRAM, PHASE I: ADVANCED TERRESTRIAL RADIOISOTOPE POWER SYSTEMS CONVERTER DEVELOPMENT PROGRAM Quarterly Report, 1 Feb.–31 Mar. 1967
H. F. Schwarz 22 May 1967 182 p refs
(Contract AT(30-1)-3824)
(MMM3824-0006; QR-1) CFSTI: HC$3.00/MF$0.65

The SNAP-23A development effort toward the design, fabrication, and test of a thermoelectric converter design to be used as a component in the 60-watt SNAP-23A Terrestrial Radioisotope Power Supply System is described. Progress is reported on the 60-W converter development, based on the SNAP-23 Program baseline technology, and the thermoelectric couple improvement program, designed to incorporate material and fabrication technology improvements into thermoelectric units capable

of achieving the desired 10-year life objective of the SNAP-23A. Progress is also reported on the following tasks: converter weldment stress analysis; converter support system spring rate analysis; outer case and cold frame analysis; hot frame interface analysis; thermoelectric couple design procedures; computer programming for converter performance; development of 10-couple module variables matrix; hardware design and development; and thermal analysis of 10-couple module. NSA

N67-37434# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
EFFECTS OF UO_2 CRYSTALLINE BINDING ON DOPPLER COEFFICIENTS CALCULATIONS FOR FAST REACTOR SYSTEMS
R. E. Schenter Jun. 1967 12 p refs
(Contract AT(45-1)-1830)
(BNWL-442) CFSTI: HC $3.00/MF $0.65

The change in the Doppler coefficient due to crystalline binding effects was studied for ^{238}U in a UO_2 lattice for fast reactor systems. The "weak binding," or the short compound nucleus lifetime (SCNL) approximation was used, where the ^{238}U atoms in the UO_2 lattice are treated as a free gas with an effective temperature. Calculations were made to determine the dependence of effective temperature versus temperature using the experimental phonon distribution of Dolling, et al. Comparisons were also made with effective temperatures obtained assuming a Debye model for the crystal. It was found that for temperatures above 300°K the effective temperature dependence was well represented by the Debye model ($\theta_D \approx 620$°K). The temperature dependence of the reactivity was calculated for the ANL critical assembly, ZPR-III, 47, with the result that incorporation of the crystalline binding effects caused the calculated Doppler coefficient (dk/dT) to diverge from the "1/T" rule in the low temperature region, in qualitative agreement with the experimental results of Reynolds and Stewart. Author (NSA)

N67-37483# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS Quarterly Progress Report, Nov. 1966–Jan. 1967
15 Feb. 1967 203 p refs
(Contract AT(45-1)-1830)
(BNWL-CC-1053) CFSTI: HC $3.00/MF $0.65

Research progress is reported on fast-neutron spectra and radiation damage rates, radiation effects on reactor structural materials, in-reactor testing of steels, effects of radiation on refractory metals and heat-resisting alloys, tensile tests, radiation metallurgy, radiation damage to metals, fission track dosimetry, irradiation facilities, and corrosion of superalloys and refractory metals. NSA

N67-37488# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
THE ATR HIGH TEMPERATURE HELIUM LOOP MODEL DESCRIPTION AND CAPABILITIES
P. M. Jackson and R. J. Evans Jun. 1967 18 p refs
(BNWL-419) CFSTI: HC $3.00/MF $0.65

Construction features, current application, and potential future applications of a high temperature, high purity, He gas loop is described. The loop is an approximate one-tenth scale model of a high temperature materials-testing He gas loop under construction at the Advanced Test Reactor (ATR). The model loop is being used as a pilot operation for the ATR gas loop and as an out-of-reactor control in evaluation of specimen assemblies to be irradiated in the ATR gas loop. Author (NSA)

N67-37495# Rocky Flats Div., Dow Chemical Co., Golden, Colo.
CALCULATED CRITICAL RADII OF SPHERES OF PLUTONIUM 239 AND URANIUM 233 WITH VARIOUS SPHERICAL REFLECTORS
Donald R. Ferguson and Donald C. Coonfield 9 Jun. 1967 10 p refs
(Contract AT(29-1)-1106)
(RFP-936) CFSTI: HC $3.00/MF $0.65

Calculated critical radii of spheres of 100% plutonium-239 and 100% uranium-233 are listed as a function of reflector thickness of several types of reflectors. Corresponding critical masses are calculated using the listed critical radii. Author (NSA)

N67-37496# Sandia Corp., Albuquerque, N. Mex.
FUEL ROD TRANSIENT HEAT TRANSFER: EXPERIMENTS AND ANALYSIS
Joseph B. Rivard and Roger J. Mattson Jun. 1967 16 p refs
(SC-RR-67-19) CFSTI: HC $3.00/MF $0.65

The transient heat transfer and thermal-hydrodynamics of pool-type pulse reactors are considered. Experimental investigation of the transient thermal behavior of pulsed fuel elements, cooled by natural convection, is reported. A preliminary description of the thermal-hydraulic model is given in which two distinct transient heat transfer modes are identified. Author (NSA)

N67-37515# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
FAILURE ANALYSES AND PROPERTIES OF SAFETY ROD GUIDE TUBES FROM THE HWCTR
R. P. Marshall and C. L. Selby Apr. 1967 21 p refs
(Contract AT(07-2)-1)
(DP-1077) CFSTI: HC $3.00/MF $0.65

Four of the six safety rod guide tubes in the Heavy Water Components Test Reactor at the Savannah River Plant failed after operating ≈6000 hours at 200°C; two tubes contained 2- to 3-inch longitudinal cracks, one contained a 30-inch crack, and one contained short cracks, a long crack, and a complete transverse fracture. During service, the six tubes each had experienced between 222 and 327 test drops of the safety rods at 22 to 260°C. The failures were caused by stress pulses generated in the tubes during hydraulic deceleration of the falling safety rods. The cracks were initiated by low-cycle fatigue, due to repeated drops at elevated temperatures, and were propagated by drops at low temperatures. Residual stresses and high H contents, both from fabrication and from high in-pile corrosion rates, were significant contributing factors. In-pile corrosion rates were three to ten times the rates that would be expected in autoclave tests at the same temperature. Author (NSA)

N67-37518# Battelle Memorial Inst., Columbus, Ohio.
CALCULATIONS ON THE COLLISIONAL COALESCENCE OF FISSION-GAS BUBBLES IN SOLID FUELS
Eugene M. Baroody 13 Jun. 1967 55 p ref
(Contract W-7405-ENG-92)
(BMI-1805) CFSTI: HC $3.00/MF $0.65

A largely analytical study is made of the collisional coalescence of spherical gas-filled pores similar to those involved in the swelling of nuclear fuel materials. The work is based on the integro-differential equation for the distribution in radius $\phi(r,t)$ and emphasizes problems for which similarity (or self-preserving) solutions can be obtained readily. For these cases ϕ is a power of the time, t, multiplied by a function of a single variable $G(\phi)$, where $\phi = rt^{\beta}$. Physical assumptions are essentially the same as adopted by earlier workers, and major attention is given to situations where pore mobility results from surface diffusion. The time dependence of the pore density and of the moments (r^n) appears immediately, and convenient procedures lead, with little

computation, to estimates of the magnitudes of the lower moments. The estimates are good, as comparisons with the numerical studies of Gruber show. Limited results are also obtained on how a simple initial distribution goes over quickly to the similarity form. A few results are given for related problems, such as the coagulation by Brownian motion of liquid droplets in colloidal suspension. It is pointed out that some problems of interest for pore coalescence appear not to lead to solutions of the similarity type. Author (NSA)

N67-37518# Atomics International, Canoga Park, Calif.
THERMAL BEHAVIOR OF SNAP 8 REACTOR DURING ATMOSPHERIC REENTRY
L. D. Montgomery, J. E. Arnold, E. M. Mouradian, and D. K. Nelson 1 May 1967 66 p refs
(Contract AT(04-3)-701)
(NAA-SR-12355) CFSTI: HC $3.00/MF $0.65

An analysis was made to simulate the thermal behavior of a SNAP-8 type reactor system during reentry into the earth's atmosphere. The objective was to determine whether sufficient ablation will occur to release the reactor core at an an altitude that will ensure complete burnup of the fuel elements in the upper atmosphere. Results show that the SNAP-8 reactor vessel will not ablate to a sufficient extent, for probable modes of reentry, to release the fuel elements at altitudes necessary to obtain complete fuel ablation. Author (NSA)

N67-37519# Atomics International, Canoga Park, Calif.
SNAP 8 CONFIGURATION REENTRY HYPERSONIC HEATING RATES DERIVED FROM A SHOCK TUNNEL TEST
D. K. Nelson 1 May 1967 30 p refs
(Contract AT(04-3)-701)
(NAA-SR-12383) CFSTI: HC $3.00/MF $0.65

Reentry aerodynamic heating distributions for the SNAP 8 configuration have been obtained based on hypersonic shock tunnel experiments. The heat-transfer correlations are given as a function of angle of attack from 0 to 70 degrees. The perturbative effect of piping on the flow field, and consequently the heat-transfer distributions, was also investigated at the 30- and 60-degree angle-of-attack positions. Test objectives and the criteria upon which the experimental work was based are given along with a description of the Cornell 48-in. Hypersonic Shock Tunnel, test model, and heat-transfer instrumentation. The heat-transfer data have been normalized by the stagnation point value of a hemisphere with the reactor vessel radius. This heat-transfer rate (29.05 Btu/ft^2-sec) was obtained experimentally in the shock tunnel and verified by theory. In addition to the data point values of the sensors in tabular form, schematics of the heat-transfer rates on the reactor-piping complex are given for cases where flow emanates from 0, 30, and 60 degrees from the SNAP 8 system centerline. Aerodynamic heat-transfer rates are shown as functions of angle of attack for locations on the system piping, vessel head, and reactor vessel. Author (NSA)

N67-37643# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
FABRICATION OF REBUILT BONUS REACTOR SUPERHEATER FUEL ASSEMBLY
G. M. Slaughter, E. A. Franco-Ferreira, E. C. Kirstowsky, K. K. Klinot, E. L. Long, Jr. et al Jun. 1967 163 p refs
(Contract W-7405-ENG-26)
(ORNL-4072) CFSTI: HC $3.00/MF $0.65

A superheater fuel assembly for the Boiling Nuclear Superheat (BONUS) Reactor that had been destructively dismantled for examination has been successfully rebuilt. The renovation of salvaged parts, the procurement of replacement parts, the fabrication of a new set of fuel rods, and final assembly into the rebuilt unit are described. Procedures developed and adopted for weld and braze qualification, process control, testing, and inspection to ensure product reliability are also covered. The original design of the Inconel-clad UO_2 fuel rods was modified to ease fabrication and upgrade service performance. In addition steps were taken to ensure a fine grain size in the Inconel 600 cladding tubing after brazing of spacers. The reconstruction of the unit was basically a rod-type fuel element fabrication operation. Thirty-two fuel rods were made and incorporated into the final assembly. Cracking in the weld regions resulted in leaks that rejected four rods. The findings of a metallographic examination of some of the cracked regions are discussed. Author (NSA)

N67-37645*# General Electric Co., Pleasanton, Calif. Nuclear Thermionic Powar Operation.
HIGH TEMPERATURE COMPATIBILITY OF UO_2 WITH W-25 WT PERCENT RE Topical Report
R. A. Ekvall and J. O. Hegland May 1967 70 p refs
(Contract NAS3-2544)
(NASA-CR-72282; GEST-2099) CFSTI: HC $3.00/MF $0.65
CSCL 18J

The high temperature compatibility of two types of clad fuels, UO_2 contained in tungsten-25 wt% rhenium (W-25 wt % Re), and tungsten-60 and 70 vol % UO_2 cermets (W-60 vol % and 70 vol %) contained in W-25 wt % Re was investigated. Samples of stoichiometric UO_2 clad with W-25 wt % Re were tested isothermally in cesium (Cs) vapor of 1 to 5 torr at temperatures of 1800 to 2200°C for times up to 5000 hours. In addition, some samples of stoichiometric UO_2 clad with W-25 wt % Re were subjected to thermal cycling from a maximum temperature of 2200°C to a minimum of 725°C for relatively short times in a vacuum environment. Cermet fuels of W-60 and 70 vol % UO_2 clad in W-25 wt % Re were tested in a vacuum ($\approx 10^{-6}$ torr) at 1800 and 2000°C for times to 500 hours. The results of the evaluation of the compatibility as determined by metallographic analysis, electron microprobe, emission spectroscopy, and wet chemistry are presented. Author

N67-37773# Ceskoslovenska Akademie Ved, Rez.
THE DEVELOPMENT OF HEAT IN FUEL ELEMENTS BY ABSORBED γ-RADIATION AND BY FISSION WITH FAST NEUTRONS. DESCRIPTION OF THE MC-γ-1 PROGRAM [VYVIN TEPLA V PALIVOVEM CLANKU POHLCOVANIM γ-ZARENI A STEPENIM RYCHLYMI NEUTRONY. METODIKA VYPOCTU POPIS PROGRAMU MC-γ-1]
J. Jakab Dec. 1966 23 p refs In CZECHOSLOVAKIAN
(UJV-1724)

A method of calculation of the spatial distribution of the heat sources in an infinite reactor lattice with uniform spacing is given. The Monte Carlo method is used for calculations. The sources of heat are: absorption of energy of γ-radiation and fast neutron fission. The method for γ-quanta is described in detail and the differences between the end-product of γ-quanta and neutrons are presented. It is assumed that the thermal neutron flux distribution is known. The program MC-Gamma-1 for γ-quanta is described; the results of calculations for the fuel element ϕ 112 mm. of the reactor KS-150 are presented. On the basis of the results, the usefulness of the program is shown for a reactor of definite dimensions. NSA

N67-37779# Brookhaven National Lab., Upton, N. Y.
LIGHT WATER MODERATED BREEDER
B. Manowitz Jun. 1967 14 p refs Presented at 13th Meeting of the Am. Nucl. Soc., San Diego, Calif.
(BNL-11463; CONF-670802-14) CFSTI: HC $3.00/MF $0.65

A concept for a light-water-moderated Th–^{233}U epithermal breeder reactor is presented. The core physics calculations are

tabulated and discussed. A comparison between epithermal and fast breeders is given. Economic aspects of the epithermal breeder are considered. NSA

N67-37836 Joint Publications Research Service, Washington, D. C.
CRITICAL PARAMETERS OF FISSIONABLE MATERIALS SYSTEMS AND NUCLEAR SAFETY (A HANDBOOK)
B. G. Dubovskiy, A. V. Kamayev, F. M. Kusnetsov, G. M. Vladykov, V. N. Gurin et al 23 Aug. 1967 176 p Transl. into ENGLISH of the book "Kritcheskiye Parametry. Sistem s Delyashchimisya Veshchestvami Iyadernaya Bezopasnost" Moscow, Atomic Publ. House, 1966 p 1–226
(JPRS-42322; TT-67-32961) CFSTI: $3.00

Nuclear safety is discussed in terms of the criticality concept and the factors affecting criticality, fissionable materials, and general principles for providing nuclear safety. Problems connected with the theory and methods of designing homogeneous reactors are considered, with attention focused on hydrogen-containing reactor design. Multigroup methods of solving reactor equations are mathematically described, along with the techniques for computing the critical masses of nuclear reactors. The critical parameters of hydrogen-containing systems are identified, and the importance of calculating the size–shape factors in computing complicated geometric configurations is demonstrated. Four methods are given for computing interacting subcritical assemblies of fissionable materials: equivalent dimensions, safe solid angle, interaction parameter, and homogenization. Experimental results are included. Basic norms for insuring nuclear safety are tabulated. M.G.J.

N67-37854# Oak Ridge National Lab., Tenn.
FUEL AND BLANKET PROCESSING DEVELOPMENT FOR MOLTEN SALT BREEDER REACTORS
W. L. Carter and M. E. Whatley Jun. 1967 50 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1852) CFSTI: HC $3.00/MF $0.65

Evaluations of Molten Salt Breeder Reactors pointed the direction of desirable design, research, and development for improving the economic and breeding performance of these systems. In design, the conventional concept of processing fuel in facilities that are separate from the reactor plant needs to be abandoned in favor of integrating the processing operations directly into the reactor building. For the MSBR, only a small space is required adjacent to the reactor cells for processing cells. This arrangement allows significant savings in capital, operating, shipping, and inventory costs. Research and development showed that irradiated MSBR fuel can be decontaminated in a four-step process consisting of fluorination, UF_6 sorption, vacuum distillation, and reduction–reconstitution. These operations recover not only the uranium but also the LiF–BeF_2 carrier. Fluorination and sorption technologies are well developed for batchwise operation, having advanced through the pilot plant stage. However, for MSBR application, these two steps, as well as distillation and reduction–reconstitution, must be developed for continuous operation. These four unit processes are rather simple and straightforward; however, vacuum distillation requires a higher temperature (≈1000°C) than encountered previously in molten salt processing. Author

N67-37867# Battelle-Northwest, Richland, Wash. Pacific Nortwest Lab.
SHIELDING CALCULATIONS FOR CONCEPTUAL DESIGN OF FFTF SODIUM SYSTEMS
W. L. Bunch and R. E. Shaver Apr. 1967 31 p refs
(Contract AT(45-1)-1830)
(BNWL-388) CFSTI: HC $3.00/MF $0.65

Calculations indicate that the Na coolant in the Fast Test Reactor will attain saturated specific activities of the order of 0.1 Ci/cm^3 of ^{24}Na and 30 μCi/cm^3 of ^{22}Na. About 400 g/cm^2 of shield material will be required to protect operating personnel from the γ associated with the ^{24}Na activity. Following decay of this isotope, about 100 g/cm^2 will provide adequate shielding. Fission products entering the Na as a result of fuel cladding failures are not expected to increase basic shield requirements for the Na systems, but will probably influence conceptual design of maintenance and handling techniques for the systems. Author (NSA)

N67-37869# Los Alamos Scientific Lab., N. Mex.
FUEL CYCLE COST IMPLICATIONS OF LIQUID PLUTONIUM REACTOR FUEL
W. H. Hannum, comp. Nov. 1966 108 p refs
(Contract W-7405-ENG-36)
(LA-3655) CFSTI: HC $3.00/MF $0.65

Probable fuel cycle costs for a liquid Pu alloy fuel have been studied for a particular fast breeder reactor application. The fuel cycle costs for the liquid fuel are at least as attractive as those derived for the solid-fuel reference case, and additional studies have indicated areas in which the liquid fuel would have a definite fuel cycle cost advantage over solid fuels. Author (NSA)

N67-37873# Aeg-Kernenergieanlagen, Frankfurt am Main (West Germany).
INVESTIGATIONS ON CYCLONES FOR STEAM SEPARATION IN BOILING WATER REACTORS Quarterly Report, Oct. 1–Dec. 31, 1966
Vollradt Tischer 31 Dec. 1966 72 p
(Contract EURATOM-083-66-1 TEED)
(EURAEC-1787; Eur-3329; QR-4) CFSTI: HC $3.00/MF $0.65

The design geometry of mixture-inflow axially fed steam separators is presented. The arrangement requires steam separators located along several rows in the reactor drop space. The design criteria requires that each cyclone row have equal mass flow and uniform mixture quality. By using various guide inserts to alter flow of mixture influx, it was found that the air flow did not differ by more than ±4%, and the water flow by more than ±6% from the average load from the front and rear cyclone row. After changing from air–water to steam–water mixtures under reactor conditions, even more uniform distribution of mass flow is expected. Therefore, the mixture flow can be satisfactorily controlled with guide plates. NSA

N67-37875# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
IRRADIATION BEHAVIOUR OF EXPERIMENTAL FUEL ASSEMBLIES OF UO_2–PuO_2 AND ThO_2–PuO_2
T. Jeffs Feb. 1967 29 p refs Presented at the IAEA Symp. on the Use of Plutonium as a Reactor Fuel, Brussels, 13–17 Mar. 1967
(AECL-2674; CONF-670306-4) Available from Atomic Energy of Canada, Ltd., Chalk River: $1.00

The results are described of detailed examination of eleven Zr-2 clad oxide fuel elements after irradiation in NRX. Six elements were of UO_2–PuO_2 and these are compared with two enriched UO_2 elements after operation at heat ratings ($\int_{T_s}^{T_o}\lambda(\theta)d\theta$) up to 63 W cm^{-1} to an average burnup of 1550 MWd/Te oxide. The other three elements were ThO_2–PuO_2 containing up to 1.93 wt % PuO_2 and operating at ratings up to 77 W cm^{-1} ($\int_{T_s}^{T_o}\lambda(\theta)d\theta$) to a maximum burnup of 1260 MWd/Te oxide. The results reported comprise profilometer data, fission gas release, metallographic examination and autoradiography. Author (NSA)

N67-37876# Japan Atomic Energy Research Inst., Tokyo.
EXPERIMENTAL AND THEORETICAL STUDIES OF THE EXPANSION JOINTS (BELLOWS) IN THE PIPING SYSTEMS OF NUCLEAR REACTORS
Shohachiro Miyazono Nov. 1966 35 p refs In JAPANESE and ENGLISH
(JAERI-1130)

In the piping systems of various nuclear power plants, U-shaped expansion joints are employed to absorb the vibration, expansion, and tension which are caused by thermal or mechanical loads. The theoretical and experimental results which were acquired on some expansion joints when a mechanical load is applied to them are described. A theoretical analysis of a U-shaped expansion joint was made by separating into three parts, namely an annular plate, inner and outer toroidal shell of circular cross section. The basic equations for bending and normal force are used for each part and the solutions are worked out in the form which satisfies the conditions of compatibility and continuity in two boundaries. The theoretical and experimental results for some expansion joints which are generally employed in the piping systems of nuclear and chemical plants are compared. In the experiment, strains were measured with strain gages. The results agree with the accuracy of about 10%. Author (NSA)

N67-37894# Bettis Atomic Power Lab., Pittsburgh, Pa.
THE MULTIMODE SYNTHESIS APPROXIMATION FOR SPACE-TIME REACTOR DYNAMICS: AN APPRAISAL OF FINITE DIFFERENCING METHODS
W. G. Clarke and S. G. Margolis May 1967 76 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-635) CFSTI: HC $3.00/MF $0.65

An appraisal of possible finite differencing methods for the multimode time synthesis approximation to space-time reactor kinetics with emphasis on accuracy, stability, computer economy, and programming simplicity is presented. A FORTRAN IV digital program for the CDC-6600, MUMKIN-2, was used to perform these numerical studies and is described. The program is used to solve the multimode kinetics equations in the absence of reactivity feedback for up to nine trial functions and six delayed neutron groups. The program description includes an example of how multimode kinetics parameters can be generated by arithmetical operations on the synthesis edits of an existing one dimensional neutron diffusion program for up to four energy groups and 100 mesh points. Special features of the program include an automated data link for computing the multimode kinetics parameters ρ, $\bar{\beta}$ and Λ and a technique to achieve time synthesis with discontinuous sets of trial functions. Author (NSA)

N67-37902# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
IRRADIATION BEHAVIOR OF Eu_2O_3—STAINLESS STEEL DISPERSIONS
C. F. Leitten, Jr., A. E. Richt, and R. J. Beaver Jun. 1967 45 p refs
(Contract W-7405-ENG-26)
(ORNL-4104) CFSTI: HC $3.00/MF $0.65

Acceptable components were made for the SM-1 reactor with stainless steel containing less than 0.03% Si. Irradiation in the ETR verified that these mixtures of Eu_2O_3 with low-Si stainless steel remained stable through long exposures to thermal neutrons. Mixtures containing 20, 30, and 40 wt % Eu_2O_3 were tested to exposures ranging from 0.7×10^{21} to 4.5×10^{21} neutrons/cm^2 at a temperature estimated to be 150°F. No instabilities or reactions were observed by microstructural examination and dimensional measurement. Eu_2O_3 is prone to attack when exposed to water. Irradiation did not appear to have any effect on this property. Mass spectrographic analyses of the Eu after irradiation indicated that the actual burnup of Eu was about an order of magnitude less than that predicted by unperturbed neutron flux values or ^{60}Co monitoring. NSA

N67-37907# Technische Hochschule Stuttgart (West Germany).
STATUS REPORT, 1966 [WISSENSCHAFTLICHER BERICHT, 1966]
May 1967 365 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-46)

A status report of the research work in the field of thermionic reactors as power supply for space crafts carried out at the Institut für Kernenergetik der Technischen Hochschule Stuttgart in 1966 is presented. The contributions are dealing with reactor physics, neutron and γ-ray shielding, theoretical and experimental investigations in thermionic converter physics and problems of heat transfer by fin-tube radiators and heat-pipe radiators. Author (NSA)

N67-37939# Nuclear Materials and Equipment Corp., Apollo, Pa.
DEVELOPMENT AND TESTING OF PuO_2–UO_2 FAST REACTOR FUELS Progress Report, Jul. 1–Sep. 30, 1966
Apr. 1967 32 p refs
(Contract AT(30-1)-3524)
(NUMEC-3524-27) CFSTI: HC $3.00/MF $0.65

The 41 fuel capsules schedules for irradiation in EBR-II have been shipped for non-destructive tests. The nineteen (19) C series capsules were loaded into the reactor. The eleven (11) A and eleven (11) B series are still undergoing testing. The twenty (20) library sample fuel rods have been fabricated and tested and are stored. The metallography of the final compatibility samples has been completed. Powders of two compositions—UO_2 –12.5 wt % PuO_2 and UO_2–20 wt % PuO_2 were mixed with 316L and Hastelloy X metal powders and sintered at 1250°C and 1350°C for 24 hours in an N_2–6 vol % H_2 atm. There was no indication of a reaction in any of the samples when viewed at 1000 X. There was evidence of metal melting in several samples. The thermal expansion by X-ray diffractometer of UO_2–12.5 and 20 wt % PuO_2 in various atmospheres has shown anomalous results. Data is presented and possible explanations for the anomaly are given. Author

N67-37954# Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires.
MEASUREMENT OF MODERATED NEUTRON FLUXES USING Au–La–Co–Mn SANDWICH DETECTORS [MESURE DE FLUX DE NEUTRONS EN RALENTISSEMENT AU MOYEN DE DETECTEURS EN SANDWICHES Au–La–Co–Mn]
Laurent Costa (Ph.D. Thesis—Paris Univ., Orsay, France) Mar. 1967 100 p refs In FRENCH
(CEA-R-3200)

In order to measure the energy spectra of moderated neutrons in reactors or their protections, it is possible to improve resonating detectors by using three together: the difference between the activities of the exterior detectors and that of the central detector is proportional to the neutron flux at the resonance energy. The sensitivity obtained is lower but the energy selectivity is better than with simple detectors. The object of this work has been to develop this technique for four substances: gold, lanthanum, cobalt and manganese which have resonance energies of 4.9, 73.5, 132, and 337 eV respectively. Author (NSA)

N67-37963# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
ANALYSIS OF A UO_2 19-ROD CLUSTER EXPERIMENT WITH THE RBU MONTE CARLO CODE

D. H. Thomsen 6 Jun. 1967 14 p refs Presented at the 13th Ann. Meeting of the Am. Nucl. Soc., San Diego, Calif.
(Contract AT(45-1)-1830)
(BNWL-SA-1176; CONF-670602-16) CFSTI: HC $3.00/MF $0.65

The neutron flux distribution of a 19-rod urania cluster are calculated. The lattice constants for the cell, experimentally determined in the PCTR, are presented. Comparisons are made of the experimental and calculated values. NSA

N67-37979# Oak Ridge National Lab., Tenn.
HIGH FLUX ISOTOPE REACTOR Quarterly Report, Jan.–Mar. 1967
R. V. McCord and B. L. Corbett 9 Jun. 1967 29 p
(Contract W-7405-ENG-26)
(ORNL-TM-1895) CFSTI: HC $3.00/MF $0.65

A summary of operations of the HFIR is given. The special testing program is discussed. The tests include control-plate guide bearings, depleted fuel element shipping cask, hydraulic rabbit tube, target rod rupture, xenon transients, and water systems. NSA

N67-37983# Sandia Corp., Albuquerque, N. Mex.
CORE CALCULATIONS FOR SANDIA PULSE REACTOR II (SPR II)
W. H. Schmidt May 1967 31 p refs
(Contract AT(29-1)-789)
(SC-RR-66-2643) CFSTI: HC $3.00/MF $0.65

A summary of results and calculation methods, as well as justification for design criteria, is presented for the Sandia Pulse Reactor II (SPR II). Two-dimensional multigroup neutron transport theory calculations were made with the LASL DDK computer program. The results include core size, reactivity worths of core components, and temperature and neutron flux profiles. Author (NSA)

N67-37988# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
ENGINEERING DEVELOPMENT DEPARTMENT Quarterly Report, Apr.–Jun. 1966
H. Harty, J. M. Batch, L. T. Pedersen, R. G. Wheeler, and J. C. Fox Apr. 1967 76 p refs
(Contract AT(45-1)-1830)
(BNWL-367) CFSTI: HC $3.00/MF $0.65

A discussion of cermet fuel analysis for the FFTF is presented. A feasibility study on gas cooling of fuel subassemblies is discussed. A synopsis of the survey of liquid metal test facilities is given. A brief summary of the nuclear electric plant capital costs vs. site location is presented. Calculational analysis of cross-flow mixing between flow channels during boiling is discussed. Neutron kinetics of coupled reactor theory are presented. Crack propagation test results on Zr 2.5% Nb pressure tubing are tabulated. A discussion of safety rod modification, oscillator development, and work done for the Phoenix fuel program in the HTLTR are discussed. Studies of radiation damage to reactor metals in the ATR gas loop are presented. The sutdy of upstream boiling burnout is discussed. The heat transfer calculations for the FERTF fuel basket are discussed. Wrok done with the PRTR is summarized. Results of aerosol tests done in the Containment Systems Experiment are tabulated. The testing of small vessels is discussed. NSA

N67-37997# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
FUEL BURNUP AND REACTIVITY CHANGES
A. G. Ward Mar. 1967 16 p refs Presented at the IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, 10–14 Apr. 1967
(AECL-2865; CONF-670418-1) CFSTI: HC $3.00/MF $0.65

The NPD reactor is operating with a natural-U fuel charge near equilibrium burnup for a bi-directional fuelling cycle. It is a well controlled critical experiment with irradiated fuel and gives a direct answer to the fuel burnup for this situation. It can be used as a reference experiment to normalize lattice codes, and only minor extrapolation is required to calculate burnup for larger reactors. Oxide samples from an irradiated NPD fuel bundle have been analyzed chemically for the Pu/U ratio, and mass spectrometric analyses were made of the Pu and U. The ^{235}U burnup agrees well with the predicted value; the Pu content and isotopic composition are compared with calculations on several computer programs. Author (NSA)

N67-38012# Thermo Electron Engineering Corp., Waltham, Mass.
RESEARCH AND DEVELOPMENT OF VACUUM FOIL-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS Quarterly Progress Report, Feb.–Apr. 1967
J. B. Dunlay, J. Fronduto, M. L. Paquin, and V. L. Poirier 31 May 1967 42 p
(Contract AT(30-1)-3634)
(ALO-3634-5) CFSTI: HC $3.00/MF $0.65

Progress is reported on the development of high-temperature thermal insulation for radioisotope power systems. The following were investigated: planar heat transfer test results for spray-coated Mo–ThO_2 insulation samples; cylindrical heat transfer test results for W–ThO_2 and Ta–ThO_2 insulation samples; life-test results on the thermal and outgassing characteristics of insulation samples after 1000 hours at 1700°C and 1900°C. Author (NSA)

N67-38027# Arizona Univ., Tucson. Dept. of Nuclear Engineering.
EXAMPLE OF TWO-REGION REACTOR STABILITY WITH DELAYED NEUTRONS
David L. Hetrick and Theodore R. Schmidt 1966 25 p refs
(Contract AT(04-3)-670)
(TID-23844) CFSTI: HC $3.00/MF $0.65

The linearized point-reactor model in the prompt-jump approximation is used with a simple two-region lumped-parameter model for heat transfer to analyze reactor stability. The effect of neglecting delayed neutrons is discussed, and an example is presented which shows that delayed neutrons can impair stability under certain conditions. Results are presented as stability regions in a parameter space of the two reactivity coefficients and as power–temperature phase-plane plots obtained with an analog computer. A wide range of stability is demonstrated for combinations of prompt-positive and delayed-negative reactivity feedback. Author (NSA)

N67-38045# Argonne National Lab., Ill. Reactor Physics Div.
PHYSICS MEASUREMENTS WITH MODIFIED DILUENT COMPOSITIONS IN TUNGSTEN-BASED ALUMINUM-REFLECTED FAST REACTORS
W. G. Knapp and R. C. Doerner Feb. 1967 39 p refs
(Contract W-31-109-ENG-38)
(ANL-7207) CFSTI: HC $3.00/MF $0.65

A typically W-diluted, nuclear-rocket, metal-fueled assembly composition was used as a reference for studies of other core diluent materials. In combination with W, the other core diluent materials are depleted U, W, W–Re, and graphite. The critical experiments performed with each assembly are discussed at length. The critical masses of the various ZPR-9 assemblies are tabulated. The H central worths in the W, W–Re, graphite, and a typical loading for a W rocket-reactor are listed. Results of kinetics measurements and reaction rate measurements are detailed for all assemblies. Reactivity worths of B in the reflector are tabulated. A complete listing of measured vs. calculated parameters for W-based Al-reflected ZPR-9 assemblies is included. NSA

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N67-36767# Texas Univ., Austin. Electroacoustics Research Lab.

AXISYMMETRIC STRESS-WAVE PROPAGATION ACROSS THE PLANE INTERFACE BETWEEN TWO CYLINDRICALLY-BOUNDED MEDIA

Gerald Kirby Miller, II 1 Jul. 1967 153 p refs

(Contract Nonr-4690(00))

(Rept.-1-67; AD-655689)

Presented are the analytical derivations, the development of approximations for obtaining results, and some of the computer results in a steady-state axisymmetric stress wave propagation study focusing on the plane interface between two cylindrically bounded, coaxial, ideal media, one solid and one liquid. For stress waves in a 1-1/2 inch diameter nylon rod propagating into an equal diameter water column, acoustic fields on both sides of the interface are calculated. From these fields, intensity, power and transmission loss as a function of frequency are also calculated. Author (TAB)

N67-36776* Maryland Univ., College Park.

PROPERTIES OF CORRELATIONS OF QUANTITIES DEPENDING ON SPACE AND TIME

Kurt Suchy Mar. 1965 17 p refs

(Grant NsG-220-62)

(NASA-CR-88380; BN-394) CSCL 12A

Correlations are investigated with their Taylor expansion up to the second order. Special emphasis is given to the physical significance of some mathematically defined "velocities" and their geometrical representation. The necessary measurements are summarized and the influence of some missing measuring data is discussed. Author

N67-36778# Lockheed Missiles and Space Co., Sunnyvale, Calif.

ELECTROMAGNETIC SCATTERING BY REGULAR POLYHEDRA Final Report, 18 Apr. 1966–17 Apr. 1967

William H. Watson and Nikita Kusnezou 17 Apr. 1967 107 p refs

(Contract AF 19(628)-5926)

(AFCRL-67-0307; AD-655390)

In the report, the spherical representation method explained in The Method of Spherical Representation for Treating Electromagnetic Scattering, Final Report, AFCRL-66-91, April 14, 1966, by W. H. Watson, is elaborated to treat electromagnetic scattering by regular polyhedra. The distant scattered field is represented by means of generalized spherical functions so formulae can be obtained that represent backscattering cross section and target scattering matrix for arbitrary direction of incidence on the scatterer of given size relative to lambda. In Part I the geometry required for applying the method is worked out explicitly for the cube. In Part II the most general form is presented for the electromagnetic equation system satisfied by the field components that can be expressed in series of generalized spherical functions. As the result of this work electromagnetic scattering problems for scatterers not large compared with lambda can be solved in terms of spherical waves; from this solution the whole distant scattered field may be derived for any particular orientation of the scatterer and choice of incident polarization. Author (TAB)

N67-36790# Georgetown Univ., Washington, D. C. Dept. of Physics.

LIGHT DIFFRACTION BY ULTRASONIC SURFACE WAVES

Walter G. Mayer and Guillermo B. Lamers May 1967 29 p refs

(Contract Nonr-5037(01))

(TR-2; AD-655466)

The light intensity distribution in the orders of a diffraction pattern produced by the interaction of progressive ultrasonic surface waves and a monochromatic light beam is calculated. From the diffracted light intensity one can determine the amplitude of the surface wave, and from the spacing of the diffraction orders one obtains the velocity of the surface wave. Author (TAB)

N67-36795# Naval Ordnance Test Station, China Lake, Calif. Research Dept.

AVERAGED EQUATIONS FOR THE SLOW OSCILLATORY MOTION OF A SPINNING SHELL

W. R. Haseltine Jun. 1967 47 p refs

(NOTS-TP-4355; AD-656053)

The complete equations of motion of a spin-stabilized projectile are simplified by an approximation which averages out the fast nutational oscillation, but preserves the slow oscillatory behavior. It is shown by numerical calculations in a few examples that the resulting system predicts very well many details of the motion. Author (TAB)

N67-36799# Michigan Univ., Ann Arbor. Radiation Lab.

LOW FREQUENCY SCATTERING BY SPHEROIDS AND DISCS Interim Scientific Report

John S. Asvestas and Ralph E. Kleinman Jun. 1967 108 p refs

(Contract AF 19(628)-4328)

(AFCRL-67-0360; Rept.-7133-5-T; SR-4; AD-655782)

The problem of scattering of a scalar plane wave by a spheroid of revolution is solved for either Dirichlet or Neumann boundary conditions, arbitrary major to minor axis ratio, and arbitrary incident direction. The solution is obtained using an iterative method applied to solutions of the corresponding potential problem and is expressed as a series of products of Legendre and trigonometric functions, and ascending powers of wave number. A recursion relation for the coefficients in this series is derived. These results are employed to calculate scattering cross sections for 2:1, 5:1 and 10:1 prolate spheroids. Author (TAB)

N67-36823* Autonetics, Anaheim, Calif. Electro-Optical Lab.

THEORETICAL ANALYSIS OF ATMOSPHERIC EFFECTS ON OPTICAL PROPAGATION Final Report

20 Apr. 1967 298 p refs

(Contract NAS8-18035)

(NASA-CR-88386; C7-1004/401) CSCL 20F

Studied were the effects of atmospheric turbulence on the statistics of optical propagation, and the consequent effect of these propagation statistics on the performance of various optical systems. The work was accordingly divided into two categories: (1) propagation studies; and (2) the corresponding statistics of optical system performance. The present report is a collection of 16 self-contained papers which were prepared on analyses performed under the various tasks; with the exception of one, all papers are theoretical in nature. Five papers are concerned with the statistics of propagation. The basic parameters in measuring statistics of propagation were either the mutual coherence function or the phase, log-amplitude, or wave covariance or structure functions. One paper deals with the statistics of a geometric representation to evaluate the shape of a distorted wavefront. Eight papers are directly concerned with the effects of propagation statistics on the

performance of optical systems, among them optical collectors, optical heterodyne receivers, high altitude reconnaissance systems, and laser systems. The last two papers are concerned with experimental evidence related to the theory of optical propagation in the atmosphere and deal specifically with the Rytov approximation and laser beam scintillation measurement. K.W.

N67-36889*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
AN APPROXIMATE METHOD FOR DETERMINING ABSORPTION COEFFICIENTS
Mitchell W. Finkel Jul. 1967 18 p refs
(NASA-TM-X-55913; X-713-67-327) CFSTI: HC $3.00/MF $0.65 CSCL 20F

An approximate method has been outlined for determining the absorption coefficient μ and μ' which appears to be applicable to optically thin materials where primary scattering predominates. The method has at least the advantage of following directly from a fairly conventional measurement. The coefficients are given in terms of the reflected and transmitted fluxes weighted by their mean paths. Author

N67-36892# Navy Underwater Sound Lab., New London, Conn.
AN EMPIRICAL STUDY OF ELF AND VLF SHIELD CANS
J. Ronald Moser 23 May 1967 77 p refs
(USL-801; AD-655644)

An empirical ELF and VLF study of 1/16- and 1/32-inch-thick shield cans (stainless steel, aluminum, copper, Polyform, annealed Hipernom, and annealed and unannealed cold-rolled steel, mumetal, and Co-Netic) was performed to investigate shielding effectiveness versus frequency characteristics with emphasis on the effects of machining (notches, slots, holes, and louvers), dropping, annealing, welding, and disk grinding. The erratic nature of many of the shielding functions is explained by the resonance theory of shielding, and the shielding characteristics of certain shield cans are compared. The report also presents a brief introduction to the automated testing system used during this study to obtain the numerous shielding effectiveness versus frequency curves that were required. Author (TAB)

N67-37052# Navy Underwater Sound Lab., New London, Conn.
A CONTINUOUS GRADIENT RAY TRACING TECHNIQUE
Henry Weinberg 16 Jun. 1967 29 p ref
(USL-829; AD-655617)

A method of computing ray paths in an ocean for which the velocity gradient varies continuously with depth was developed. The ocean is divided into several horizontal layers. In each layer the velocity-depth profile is given by a four-parameter curve that permits range and travel time integrals to be evaluated in closed form. The curve fitting and ray tracing equations can readily be incorporated into computer programs. Some of the advantages of this technique and other ray tracing methods are compared. Author (TAB)

N67-37058# Michigan Univ., Ann Arbor. Willow Run Labs.
CODED RETICLES FOR FIXED-FIELD IMAGING SYSTEMS
S. Sternberg, J. Snell, and R. Nalepka Jul. 1967 37 p refs
(Contract DA-28-043-AMC-00013(E))
(Rept.-6400-113-T; ECOM-00013-113; AD-655502)

A particular class of imaging systems which produces a visible two-dimensional image of an object scene emitting or reflecting radiation in the infrared spectral region is discussed. Systems in this class produce an electrical signal proportional to a linear combination of resolution element intensities. The weightings imposed on the resolution element intensities are determined by the transmittance of a reticle placed in the image plane of the systems primary focusing optics. Time-varying weightings result from translations of the reticle within the image plane. The well-known continuous mathematical model of this type of system is reviewed, and its limitations are discussed. Then an alternate mathematical model is presented. This model defines the object scene, the electrical signal, and the final image as finite-dimensional vectors. The coding and decoding operations of the reticles are represented by matrices which transform the vector spaces containing these vectors. Designing reticle patterns is reduced to the problem of finding matrices which satisfy requirements insuring that the reticles will be realizable and capable of imaging the object scene. These requirements are discussed, and certain types of matrices which satisfy them are presented. Author (TAB)

N67-37106*# Midwest Research Inst., Kansas City, Mo.
EXTREME VACUUM TECHNOLOGY INCLUDING CRYOPUMP, GETTER-ION PUMP, DIFFUSION PUMP AND PRESSURE STANDARDIZATION STUDIES Summary Technical Report, 16 Jun. 1966–16 Jun. 1967
Paul J. Bryant and Charles M. Gosselin 17 Jul. 1967 81 p refs
(Contract NAS3-8914)
(NASA-CR-72066) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The program is divided into two major areas of concern: UHV pumping techniques and UHV pressure measurement. In the pumping technique studies, gross cryopumping capacities for helium and hydrogen on type 304 stainless steel were determined, getter-ion pumping mechanisms were studied, and diffusion pump nozzle designs were investigated. In the pressure measurement studies, an independent pressure reference employing an electron field emission microscope was established and the ion current versus pressure response curves were determined for three commercial cold cathode gauges. Author

N67-37175*# Avco-Everett Research Lab., Everett, Mass.
ADVANCED SUPERCONDUCTING MAGNETS INVESTIGATION Quarterly Progress Report, 10 May–10 Aug. 1967
Frank Di Salvo 10 Aug. 1967 54 p refs
(Contract NAS8-21037)
(NASA-CR-88501; QPR-3) CSCL 20C

Effects of the nonlinear heat transfer characteristic of helium on the terminal characteristics of a composite conductor are analyzed. An improved one dimensional model is introduced and a complete solution to the one dimensional problem is given. Results of experiments on both short samples and a large coil are reviewed. The data from the large coil shows two and three dimensional effects. It was assumed that the current in the superconductor was the critical current at the composite conductor temperature. S.P.

N67-37200# Library of Congress, Washington, D. C. Aerospace Technology Div.
SOVIET AND POLISH RESEARCH ON THE SELF-TRAPPING OF OPTICAL BEAMS IN NONLINEAR MEDIA Surveys of Foreign Scientific and Technical Literature
Yuri Ksander 23 Sep. 1967 24 p refs *Its* Work Assignment No. 71
(ATD-67-28)

Experimental and theoretical research on optical beam trapping is reviewed. Emphasis is placed on the Kerr effect and electrostriction mechanisms. Weak absorption, thermal expansion, and the brute force mechanisms are mentioned. N.E.N.

N67-37217# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
DETERMINATION OF SOME PARAMETERS OF OBLIQUE-MAGNETIZED BODIES OF ARBITRARY SHAPE [OPREDELENIYE NEKOTORYCH PARAMETROV KOSO-NAMAGNICHENNYKH DVUKHMERNYKH TEL PROIZVOL'NOY FORMY]
G. I. Menaker Jun. 1967 7 p refs Transl. into ENGLISH from Geol. i Geofiz., Akad. Nauk SSSR, Sibirsk. Otd. (Novosibirsk), no. 8, 1966 p 103–105
(ACIC-TC-1195; TT-67-62397; AD-655704)

The construction of a scheme for the numerical realization of the obtained formulas represents well known difficulties, since continuously potentical functions Z (x) and H (x) given on the final section of profile (-Rn, + Rn) and an exact determination of asymptotes A sub o and B sub o and integrals Q1 and Q2 are impossible. However, by approximate methods it is possible (with sufficiently high accuracy) to determine these values also for relatively short profiles. TAB

N67-37270# Army Electronics Labs., Fort Monmouth, N. J.
ABLATIVE LIGHT SOURCES
R. G. Buser (Inst. for Exploratory Res.) and W. P. Rahilly Jun. 1967 19 p refs
(ECOM-2842; AD-656459)

Electrical and optical properties of ablative light sources are discussed. For the range of parameters studied the observed light emission depends mainly on the pressure developed during the discharge which itself is proportional to energy delivered to the lamp. Mechanical and electrical characteristics combined with optical properties comparable to commercial flash tubes should permit useful technical applications. Author (TAB)

N67-37305# Chrysler Corp., New Orleans, La. Space Div.
ARTMANN TEST AND ITS APPLICATION TO THE ALL REFLECTING SCHMIDT TELESCOPE
Roger A. Barney 15 Jan. 1967 21 p refs
(TR-AE-66-12)

The Hartmann criterion is developed and its meaning discussed. The uncertainty in the Hartmann criterion is determined in terms of the tolerances of the measured parameters. These tolerances are shown to be more stringent for shorter telescopes. The Hartmann test is applied to the 24-inch focal length all reflecting Schmidt Telescope, using calculations made from field test data taken at Corralitos Observatory, Las Cruces, New Mexico. It is shown that the Hartmann number at the center of the field of view is comparable to the resolution of fine grain size emulsions. Author

N67-37357# Navy Underwater Sound Lab., New London, Conn.
THE CONCEPT OF A TWO-DIMENSIONAL LENSLESS INCOHERENT OPTICAL CORRELATOR
Edward S. Eby 12 Jul. 1967 12 p ref
(USL-828; AD-655822)

The simplest conceptual realization of a two-dimensional lensless incoherent optical correlator is introduced. In this naive model, the correlation function is located at infinity and permits only serial recording. A more sophisticated model of a lensless correlator is then developed which permits simultaneous recording of the correlation function located at finite distance. The theory is valid within the limitations of ray theory. Author (TAB)

N67-37373*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
FURTHER STUDIES OF A NON-LINEAR THERMO-MECHANICAL OSCILLATOR
N. H. Baker (Columbia Univ.), D. W. Moore, and E. A. Spiegel (New York Univ.) [1967] 77 p refs
(Grants NSF GP-5568; AF-AFOSR-386-62)
(NASA-TM-X-60382) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Periodic solutions of the equation $\ddot{z} + z + (T - R + Rz^2)\dot{z} + Tz = 0$ are studied numerically and, for large R and T, analytically. The periodic solutions are unstable in a small strip of the (R,T) plane whose boundaries are determined. Author

N67-37381# Columbia Univ., New York. Columbia Radiation Lab.
RESEARCH INVESTIGATION DIRECTED TOWARD EXTENDING THE USEFUL RANGE OF THE ELECTROMAGNETIC SPECTRUM Progress Report, 1 Nov. 1966–30 Apr. 1967
R. Novick 30 Apr. 1967 115 p refs
(Contract DA-28-043-AMC-00099(E))
(PR-15; AD-656618)

Contents: Metastable atoms and ions; Level-crossing and optical double-resonance spectroscopy; Collision phenomena; Atomic frequency standards; Beam maser spectroscopy; Electron excitation of molecular hydrogen; Scattering of velocity selected molecular beams; Magnetic rotation spectra; Molecular spectra of cesium; Laser studies of molecular birefringence and optical activity; Optical laser spectroscopy of fluids; Interaction between a neutral beam and a conducting surface; Adiabatic demagnetization in the rotating frame; Nuclear magnetic resonance in fine particles; Nuclear double resonance in KC103; Photon-echo resonance; Brillouin scattering; Models of planetary atmospheres; X-ray polarization; X-ray telescope. TAB

N67-37386# Bolt, Beranek, and Newman, Inc., Van Nuys, Calif.
CATEGORY SCALING JUDGMENT TESTS ON MOTOR VEHICLE AND AIRCRAFT NOISE
Karl S. Pearsons and Richard D. Horonjeff Jul. 1967 115 p refs
(Contract FA-65-WA-1260)
(DS-67-8)

Subjects rated on various adjective category scales the sounds produced by aircraft flyovers and motor vehicle drivebys. Recorded sounds were rated by college students and community residents at locations near a highway and two airports. The laboratory tests indicated that all of the category scales were similar in their relationship with acoustical measures. The correlations between the noisiness scale and various acoustical measures for the laboratory and field tests were all about equal, with perceived noise level, calculated or estimated from N-level measurements, exhibiting the highest correlation, followed by loudness level and A-level. The lowest correlation was exhibited by overall sound pressure level. Both the laboratory and field results were in good agreement and indicated little difference in ratings vs level among various sound stimuli employed during the tests. These comparisons indicate the influence of stimulus range on the magnitude and slope of the relationship between the subjective rating vs a physical noise measure. Author

N67-37412# Harvard Univ., Cambridge, Mass. Lyman Lab.
ULTRASONIC-VELOCITY MEASUREMENTS IN WATER AT PRESSURES TO 10,000 KG/CM^2
Gerald Holton Jun. 1967 31 p refs *Its* Commun. No. 6
(Contract Nonr-1866(57))
(TR-2; AD-655659)

Measurements of the velocity of ultrasonic pulses in water are presented for pressures up to about 10,000 kg/sq cm and for temperatures up to 60C. Coefficients obtained from least-square polynomial fittings of the data are also given, together with an analysis of the reliability and reproducibility of the experimental results. Author (TAB)

N67-37490# Tufts Univ., Medford, Mass. Dept. of Mechanical Engineering.
EFFECTS OF MULTIPLE PATHS ON ACOUSTICAL SIGNALS Final Report
Dwight Wayne Batteau 15 Jun. 1967 83 p refs
(Contract Nonr-494(20))
(AD-655637)

Contents: On the electrical generation and sensing of rotational stress waves in metal wire delay lines: Three dimensional stress-strain-magnetic field relations for an isotropic ferromagnetic material; An analytical and experimental study of magnetostrictive delay lines; Magnetic current twist of magnetostriction material contrasted with Wiedmanns twist. TAB

N67-37507# Kansas Univ., Lawrence. Dept. of Mathematics.
RATE OF CONVERGENCE IN SINGULAR PERTURBATIONS
W. M. Greenlee Jun. 1967 76 p refs
(Contract Nonr-583(13); Grant NSF GP-360)
(TR-12; AD-655448)

The paper obtains rate of convergence estimates for solutions of singular perturbations of linear elliptic boundary value problems. The problem can be described as follows. Let D be a domain in R superscript n and let epsilon be a positive real parameter. Consider two boundary value problems on D, (epsilon U + B) w subscript epsilon = f, Bu = f, where U and B are elliptic differential operators with the order of U greater than the order of B. The problem is to determine in what sense w subscript epsilon converges to u on D as epsilon drops to 0 and to estimate the rate of convergence. This problem is investigated in the present work with the L superscript 2 theory of elliptic partial differential problems. TAB

N67-37560*# Ohio State Univ., Columbus. ElectroScience Lab.
APPLICATION OF HOLOGRAPHY TO MICROSCOPIC OBJECTS
Gilles Griffon du Bellay [1967] 134 p refs Sponsored by ESRO, NASA and NAS
(NASA-CR-88718) CFSTI: HC $3.00/MF $0.65 CSCL 20F

The various methods of applying holography to microscopy are analyzed and discussed. The general theory of holography to the paraxial approximations with a classification of holograms in different types and a geometrical construction of the images are given. Experimental results with the technique of microholography are presented and the realization of a lensless microscope and the technique of holomicrography are recommended as the most promising. ESRO

N67-37585# Princeton Univ., N. J. Plasma Physics Lab.
TWO-DIMENSIONAL MEASURE PRESERVING MAPPINGS
John M. Greene Jun. 1967 34 p refs
(Contract AT(30-1)-1238)
(MATT-540)

A particular area-preserving mapping of a plane onto itself was studied in detail with the aid of a digital computer. A large number of fixed points, finite sets of points that transform into each other, were located and classified as elliptic or hyperbolic depending on the nature of the linearized mapping in the neighborhood. A quantity called the residue was calculated for each fixed point. This quantity can be used to predict whether other nearby fixed points are elliptic or hyperbolic. The results showed that there are considerable regions in which almost all the fixed points are hyperbolic. Further calculations were made to estimate the area enclosed by the invariant curves whose existence has been established by Moser. The boundary of this region appeared to coincide with the boundary of the region in which almost all the fixed points are hyperbolic. Author (NSA)

N67-37587# Library of Congress, Washington, D. C. Aerospace Technology Div.
FOREIGN SCIENCE BULLETIN, VOLUME 3, NUMBER 7 Monthly Review of Selected Foreign Scientific and Technical Literature
Jul. 1967 77 p ref

A survey of open Soviet literature is presented on such topics as: magnetic disc development; binary and ternary gallium and indium chalcogenide systems; Soviet popular literature as a source of intelligence; theoretical physics experimentation; hypothesis on the anti-matter nature of meteor showers; variation of average hourly VHF signal strength over mountainous terrain; stable polymers with triazine rings; and morphology and mechanical properties of vulcanized rubbers. The articles are divided into book reviews, conference papers, technical notes and surveys. R.LI.

N67-37696# Sandia Corp., Albuquerque, N. Mex.
ENERGY TRANSFER IN ELECTROSTATIC ARCS
C. F. Schroeder, Jr. May 1967 12 p refs Presented at the 5th Symp. on Electroexplosive Devices, Philadelphia
(Contract AT(29-1)-789)
(SC-DC-67-1796; CONF-670611-1) CFSTI: HC $3.00/MF $0.65

In an effort to understand energy transfer phenomena in electrostatic arcs, the development of reliable test instrumentation and the application of meaningful tests for electrostatic sensitivity evaluation of electroexplosive devices are described. NSA

N67-37795# Cornell Univ., Ithaca, N. Y. Center for Radiophysics and Space Research.
THE STABILITY OF CONTINUALLY CREATED MASS AGAINST GRAVITATIONAL DECAY
Richard L. Liboff Jun. 1967 11 p refs
(Contract Nonr-401-(60))
(CRSR-277; AD-655918)

In the steady state universe of Bondi and Gold, matter is continuously created at the rate of 10 to the -46th power gms/cc sec. Hoyle is able to come to a similar conclusion by modifying the field equations of general relativity. Both theories yield an expanding universe in which the density of matter remains constant. In the former theory matter is not conserved. More generally, in Hoyles formulation, the stress-energy tensor is no longer divergenceless, and again energy (mass) is not conserved. These theories yield a local creation of mass which in turn raises the question of the consistency of such theories with the principle of causality. In this paper we take the point of view that the static field which accompanies such a mass is initiated with the creation of that mass and propagates away from it with the speed of light. It is presumed that the mass is the source of the propagating field energy. These causality and conservation of energy (viz. the particle is born in an environment in which energy is conserved) statements give rise to a self consistent integral equation for the mass. Notwithstanding some objections the investigation is nevertheless consistent with the continuous creation hypothesis originally formulated by Bondi and Gold. TAB

N67-37911# Stanford Univ., Calif. Stanford Linear Accelerator Center.
PARAMETERS THAT AFFECT THE ACCURACY AND SETABILITY OF A MAGNETIC FIELD IN AN IRON CORE ELECTROMAGNET
J. K. Cobb and D. R. Jensen Jun. 1967 9 p Presented at the 2d Intern. Conf. on Magnet Technol., Oxford, 11–14 Jul. 1967
(Contract AT(04-3)-515)
(SLAC-PUB-321; CONF-670705-7) CFSTI: HC $3.00/MF $0.65

A detailed study of the magnitude of the effects of temperature, previous history of induction, and also the time rate of current

excitation on the induction and on the line integral of induction over a path through the magnet was made. Also a comparison between solid-core and laminated magnets and between large solid-core and small solid-core magnets was made. It was shown that the distribution of induction over the magnet pole is a function of excitation rate as well as excitation for magnets that are partially saturated. The location in the magnet where the induction is measured may therefore be important. The effects of previous history of induction on the setability of these magnets is also discussed. NSA

N67-37938# California Univ., Berkeley. Lawrence Radiation Lab.
CALCULATION OF TWO-DIMENSIONAL MAGNETIC FIELDS BY DIGITAL DISPLAY TECHNIQUES
John S. Colonias 28 Apr. 1967 14 p refs Presented at the 2d Intern. Conf. on Magnet Technol., Oxford, 1–14 Jul. 1967
(Contract W-7405-ENG-48)
(UCRL-17340; CONF-670705-5) CFSTI: HC $3.00/MF $0.65

A method by which two-dimensional (including axially symmetric) magnetic fields may be calculated by utilizing digital display techniques and the manner in which this method is used in designing magnets on line with a computer system are discussed. The digital display technique used allows the experimenter to draw the magnet geometry on a cathode-ray-tube screen, it permits the use of a light pen to introduce perturbations or alter various magnet dimensions as necessary, and it displays the resulting field distribution, along with various pertinent curves at the option of the user. The computer programs utilized in this method involve existing magnetostatic programs properly modified to include axially symmetric conditions, and their speed has been increased for fast interactions with the light pen. The utilization of this method is demonstrated by the design of an axially symmetric correlation spectrometer magnet, and it is shown that the computed results have an excellent agreement with those measured. Author (NSA)

N67-37940# Ohio State Univ., Columbus. High-Energy Physics Lab.
SPARK LOCATION ACCURACY IN MAGNETOSTRICTIVE DELAY LINE WIRE CHAMBERS
Thomas S. Clifford, Kurt Reibel, and Thomas A. Romanowski 9 May 1967 33 p refs
(Contract AT(11-1)-1545)
(COO-1545-17) CFSTI: HC $3.00/MF $0.65

The spark location accuracy in magnetostrictive delay line wire chambers was measured with cosmic rays using prototype 8 in. ×8 in. chambers on-line to a DDP 24 Computer. For a wire spacing of 0.050 the spread varied from 0.021 to 0.040 in. (FWHM) in the eight planes used. Author (NSA)

N67-37987# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
SOUND MEASUREMENTS UNDER DIFFICULT CONDITIONS OF VIBRATION AND TEMPERATURE [MESURES DE BRUIT DANS DES CONDITIONS DIFFICILES DE VIBRATION ET TEMPERATURE]
Maurice Bernard, Jean Lambourion, and Pierre Lienard 1967 5 p refs In FRENCH Presented at the Mesucora Congr., Paris, 17–21 Apr. 1967
(ONERA-TP-448/1967) CFSTI: HC $3.00/MF $0.65

Certain aerospace studies on noise and pressure measurements are briefly summarized. High noise levels near jet engines and signal transmission frequency are emphasized. Sonic boom, from 0.1 to 5.00 Hz, is illustrated. The interaction of the vibration factor is also described. R.LI.

N67-37976# Princeton Univ., N. J. Plasma Physics Lab.
ADJUSTMENT OF THE "SIRIUS" STELLARATOR
P. Ya. Burchenko, B. T. Vasilenko, E. D. Volkov, R. M. Nikoleav, V. A. Potapenko et al May 1967 18 p refs Transl. into ENGLISH from Russian Rept.
(Contract AT(30-1)-1238)
(MATT-TRANS-39) CFSTI: HC $3.00/MF $0.65

The adjustment of the magnetic system of the stellarator was conducted by magnetic measurements, correction by a single passage of a circular electron beam, and correction by multiple passage of a low-energy electron beam. The elements of the magnetic system were correctly regulated and the presence of magnetic surfaces in the corrected system in the approximation of the guiding center of a separate particle was shown by the combination of these methods. NSA

N67-37977# Technische Hochschule Carolo Wilhelmina, Brunswick (West Germany).
AN INDUCTIVE PULSE-GENERATOR FOR HIGH-CURRENT EXPERIMENTS [EIN INDUKTIVER STOSS STROMGENERATOR FUER HOCHSTROMEXPERIMENTE]
W. Koch Apr. 1967 12 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-35)

The operating principle of an inductive pulse-current generator for plasma physics experiments with high energy is described. The inductances of this generator are charged in series and discharged in parallel into the load. Such an inductive high-current pulse-generator gives the possibility of balancing the limited feeding current and the required load current. An explosion-type switch with a fuse in parallel is used. Author (NSA)

N67-38003*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
ANGULAR MOMENTUM AND THE KERR METRIC
Jeffrey M. Cohen Sep. 1967 13 p refs
(NASA-TM-X-60376) CFSTI: HC $3.00/MF $0.65 CSCL 20J

For Kerr's rotating metric, it is shown that ma is the angular momentum of the body where m is the mass and a is the rotation parameter. This is true even for large m and a. The calculations are carried out using the exterior calculus of Cartan. Author

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N67-38728*# Farnham (Frank C.) Co., Philadelphia, Pa.
NUCLEAR PROPERTIES OF 102 ISOTOPES WITH MASS NUMBERS 255 AND 256 [O YADERNYKH SVOYSTVAKH IZOTOPOV 102-GO ELEMENTA S MASSOVYMI CHISLAMI 255 I 256]
G. N. Akap'yev, A. G. Demin, V. A. Druin, Yu. V. Lobanov, B. V. Fefilov et al Washington, NASA, Sep. 1967 5 p refs Transl. into ENGLISH from the RUSSIAN report JINR-P-2938, 1967 7 p
(Contract NASw-1497)
(NASA-TT-F-11231; JINR-P-2938) CSCL 20H

New data are given for the half-life (≈2 min) and the energy (8.08 MeV) of the α particles for No^{255}, which differ greatly from previously published values. The energy of the α decay of No^{256} was measured for the first time and was found to be 8.58 MeV. Author

N67-36804# Aerospace Corp., El Segundo, Calif. Labs. Div.
ELASTIC SCATTERING OF LOW-ENERGY ELECTRONS FROM MOLECULAR HYDROGEN
Roger L. Wilkins and Howard S. Taylor (Univ. of Southern Calif., Los Angeles) Jun. 1967 35 p refs
(Contract AF 04(695)-1001)
(TR-1001(2240-20)-14; SSD-TR-67-112; AD-655785)

The cross sections for elastic scattering of low energy electrons by molecular hydrogen are calculated by solving numerically the continuum Hartree-Fock equations for an electron moving in the potential field of the neutral homonuclear diatomic hydrogen molecule. Hartree-Fock equations make full allowance for electron exchange. The cross sections for elastic scattering of electrons by molecular hydrogen are treated with and without the assumption of electron exchange. The theoretical agreement in the exchange approximation is very good when compared with experimental data, but disappears completely when exchange is neglected. The method of calculation is based on an expansion of the continuum orbitals up to fourth order as a product of a series of spherical harmonics and radial wave functions about the molecular midpoint of the molecule. The potential field of the incident electron caused by the nuclei of the neutral molecule is expanded in spherical harmonics up to the eighth order. The continuum orbitals are substituted into the Hartree-Fock equations, integration is performed over angular coordinates, and the resulting infinite set of coupled differential-integral equations is truncated and solved numerically to a self-consistent solution by an iterative technique for three radial continuum functions. Author (TAB)

N67-36871# General Electric Co., Philadelphia, Pa. Missile and Space Div.
EVALUATION OF MULTICENTERED COULOMB AND EXCHANGE INTEGRALS INVOLVING E_g SYMMETRY
R. Platz Aug. 1967 27 p
(R67SD44) CFSTI: HC $3.00/MF $0.65

Three- and four-centered coulomb and exchange integrals used in calculating molecular orbitals and constructed from Slater wave functions are generally approximated as a series of two-center terms for purposes of integral evaluation. Since this Mulliken's approximation does not form an orthogonal set, a unitary transformation upon the initial and expanded two-center forms will not give the same results. Thus one is faced with a dilemma of a hierarchy of operations—namely transformation vs. expansion. This paper discusses one such example with E_g symmetry of point group O_h used for calculating molecules with octahedral symmetry. Author

N67-36874# Illinois Univ., Urbana. Dept. of Physics.
A CONNECTION BETWEEN SU(3) AND O(4)
D. G. Ravenhall, R. T. Sharp, and W. J. Pardee [1966] 26 p refs Sponsored in part by NSF
(Contract N00014-67-A-0305-0005)
(AD-655653)

It is shown that the insertion of a barrier, in the isotropic harmonic oscillator and in the hydrogen atom, gives each system the higher symmetry usually associated with the other. The result is more general: the imposition of a reflection condition can change the symmetry from SU(3) to O(4), and vice versa. This may have implications for elementary particle symmetries. Author (TAB)

N67-36880# Atomic Energy of Canada, Ltd., Chalk River (Ontario). Nuclear Labs.
PROGRESS REPORT, APRIL 1, 1967 TO JUNE 30, 1967
Jun. 1967 69 p refs
(AECL-2752; PR-P-74) CFSTI: HC $3.00/MF $0.65

Summaries are presented on the several research projects which are being conducted. Subject matter includes the areas of nuclear physics, solid state, computation techniques, space physics, spectroscopy, neutron physics, and theoretical physics. Report and publication bibliographies are included. M.G.J.

N67-36915# Cambridge Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
A HOMOLOGICAL APPROACH TO PARAMETRIC FEYNMAN INTEGRALS
J. B. Boyling May 1967 41 p refs
(Grant AF-EOAR-65-36)
(AFOSR-67-1639; AD-655738)

The methods of homology theory are applied to Feynman integrals in alpha-space. In the case of single-loop graphs the relevant relative homology groups are computed and the results compared with those obtained by k-space methods. For graphs with more than one loop the permanent pinch difficulty is overcome by modifying the ambient manifold and applying Thoms isotopy theorem. Pinching conditions are then found for Landau singularities in which complete circuits are contracted out and for mixed second-type singularities. The breakdown of the hierarchical principle in perturbation theory is also explained from this point of view. Author (TAB)

N67-36916# Cambridge Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
FUBINI SUM RULES FOR VERTEX FUNCTIONS
I. G. Halliday and P. V. Landshoff May 1967 36 p refs Revised
(Grant AF-EOAR-65-36)
(AFOSR-67-1637; AD-655737)

The method of Amati, Jengo and Remiddi for obtaining dispersion sum rules from current algebra is analysed in some detail, for the simple case of amplitudes connecting one particle and two currents. A simple perturbation - theory model provides a warning that the assumptions made in the derivation of the sum rules may not always be valid. When they are valid they may be used to give a derivation of the sum rules that is more direct than the one using current algebra. Author (TAB)

N67-36950# Cambridge Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
VECTOR AND SPINOR CURRENT ALGEBRA AND THE N/D METHOD
I. T. Drummond May 1967 26 p refs
(Grant AF-EOAR-65-36)
(AFOSR-67-1640; AD-655745)

An N/D model of weak amplitudes analogous to the ladder approximation of Bronzan, Gerstein, Lee and Low is discussed. It is applied to the case of vector-vector current commutators and spinor-spinor anti-commutators. The model does not of course yield the detailed assumptions of current algebra but is consistent with them. It shows how these assumptions are compatible with the analyticity properties usually assumed for invariant amplitudes. By means of the model it is possible to indicate the problems involved if a boot-strap calculation is to yield the results of current algebra. Author (TAB)

N67-36982# Argonne National Lab., Ill.
STUDIES OF LOW-ENERGY NUCLEAR REACTIONS AND LEVEL DENSITIES FOR MEDIUM-MASS NUCLEI
Anastasios A. Katsanos (Ph.D. Thesis) Jan. 1967 100 p refs
(Contract W-31-109-ENG-38)
(ANL-7289) CFSTI: HC $3.00/MF $0.65

The level densities of ^{52}Cr, ^{56}Fe, and ^{32}S were investigated in a range of excitation energy up to about 20 MeV. The energy levels of ^{52}Cr and ^{56}Fe up to excitation energies of 6.3 and 6.7 MeV, respectively, were resolved from the reactions $^{52}Cr(p,p')^{52}Cr$, $^{55}Mn(p,\alpha)^{52}Cr$, $^{56}Fe(p,p')^{56}Fe$, and $^{59}Co(p,\alpha)^{56}Fe$ with thin targets. The outgoing particles were analyzed with a single-gap broad-range magnetic spectrograph. By analyses of the spectra in the continuum according to the evaporation theory, the level densities of the residual nuclei, up to an excitation energy of 8 MeV, were calculated. In addition, the excitation functions for the reactions $^{55}Mn(p,\alpha)^{52}Cr$, $^{31}P(p,\alpha)^{28}Si$, and $^{51}V(p,\alpha)^{48}Ti$ were obtained from experiments with surface-barrier solid-state detectors; and the average widths of the compound nuclei ^{52}Cr, ^{56}Fe, and ^{32}S were calculated at excitation energies around 20 MeV. Absolute values of the cross sections for the reactions $^{55}Mn(p,\alpha)^{52}Cr$ and $^{51}V(p,\alpha)^{48}Ti$ were also obtained. The experimental widths were compared with values calculated optical-model transmission coefficients. Finally, the level density up to about 20 MeV of excitation energy was calculated for each of the three nuclei. The results are compared with curves derived from the Fermi-gas and constant-temperature models. NSA

N67-37006# Ballistic Research Labs., Aberdeen Proving Ground, Md.

NEUTRON SPECTRAL MEASUREMENTS BY MAGNETIC ANALYSIS OF RECOIL PROTONS

Carmen M. Cialella, John M. Connor, and Charles W. Hoffman May 1967 36 p refs

(BRL-MR-1841; AD-655581)

The spectral distribution of neutrons from the TRIGA Mark F Reactor at the U.S. Army Harry Diamond Laboratories was measured with a magnetic neutron spectrometer. This instrument is a broad range, low deflection spectrometer which utilizes the magnetic analysis of protons recoiling from a thin polyethylene radiator. The spectrometer will cover an energy range from 0.5 to 17 MeV with a single magnetic field setting. The spectrometer has an array of 40 solid-state detectors placed along the focal line and includes the associated electronics. This provides the instrument with the capability of measuring the entire spectrum from either pulsed or steady state sources. Measurements of the neutron spectrum with the reactor in the steady state mode were made using four radiators of different thicknesses. Measurements were made of the power output of the reactor in the pulse mode. The width of the reactor pulse was measured to be 11.0 ms (full width at half maximum). Author (TAB)

N67-37017*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

APPROXIMATE FORMULAS FOR THE INTENSITY OF ELECTRONIC TRANSITIONS IN DIATOMIC MOLECULES

T. M. Helliwell (Harvey Mudd Coll.) and W. A. Menard 1 Sep. 1967 13 p refs

(Contract NAS7-100)

(NASA-CR-88522; JPL-TR-32-1168) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Approximate formulas are derived for the intensity of diatomic molecular electronic transitions. The formulas correspond to various models of the spectrum, ranging from a monochromatic approximation to others in which more details of the vibrational and rotational structure are taken into account. Some of these methods are well known, while others appear to be new. Choice of the appropriate method in a given circumstance depends upon the spectral shape, knowledge of the molecular parameters, and the desired accuracy of the calculation. Each model is applied to the CN violet system to illustrate its accuracy. Author

N67-37020 Tokyo Univ. of Education (Japan). Dept. of Physics.

CURRENT-ALGEBRA CALCULATION OF THE Λ TO Σ RATIO IN THE ISOSPIN-1 S-WAVE $\bar{K}$ REACTION

Syurei Iwao [1967] 4 p refs

(TUEP-67-17)

The quark model approach is compared to the current algebra calculation of the ratio of the Λ to Σ in the isospin-1 state for the S-wave $\bar{K}^-_p$ reaction. This quantity and the relevant parameters are estimated, assuming the partially-conserved axial vector current, the soft pseudoscaler meson hypothesis, and the SU(3) symmetry. The findings show that the current algebra calculation explains, at least qualitatively, the absorptive part of the S-wave $\bar{K}N$ reaction. M.G.J.

N67-37054# Naval Radiological Defense Lab., San Francisco, Calif.

NEUTRON ENERGY SPECTRUM—A CLASSICAL DERIVATION

David Hoffman 31 Jul. 1967 48 p refs

(USNRDL-TR-67-57; AD-655625)

The epithermal neutron energy spectrum is derived as a function of radial distance from a point isotropic monoenergetic neutron emitter in an infinite homogeneous scattering and absorbing medium. The derivation uses Condon and Breits neutron energy spectrum as a function of number of collisions and Chandrasekhars general solution to the problem of random flights. Author (TAB)

N67-37066 Aktiebolaget Atomenergi, Stockholm (Sweden).

TOTAL AND DIFFERENTIAL EFFICIENCIES FOR A CIRCULAR DETECTOR VIEWING A CIRCULAR RADIATOR OF FINITE THICKNESS

A. Lauber and B. Tollander Aug. 1967 46 p refs

(AE-292)

Total and differential detection efficiencies have been computed for a circular detector viewing a circular radiator of finite thickness. Isotropic, cosinus, and n–p scattering angular emission distributions of the radiated particles are considered. Tables are given for the total efficiencies as well as for the differential efficiencies in the n–p scattering case. Author

N67-37069# Kaman Aircraft Corp., Colorado Springs, Colo. Kaman Nuclear Div.

X-RAY SCATTERING BIBLIOGRAPHY Progress Report, 1 Sep. 1966–31 Aug. 1967

William J. Veigele 30 Jun. 1967 76 p refs

(Contract N00014-67-C-0154)

(KN-738-67-2(R); AD-656759)

The document contains a bibliography of experimental and theoretical papers on incoherent and coherent scattering of x rays. Entries are cross indexed for theoretical and experimental papers, and all entries are verified in Science Abstracts, Mathematical Reviews, or Nuclear Science Abstracts to facilitate obtaining listed papers or interlibrary loan. Author (TAB)

N67-37091# Columbia Univ., New York. Columbia Radiation Lab.

RESEARCH IN ATOMIC AND MOLECULAR PROPERTIES BY THE MOLECULAR BEAM METHOD Final Report, 1 Jan. 1957–30 Jun. 1966

P. Kusch Aug. 1967 10 p refs

(Contract Nonr-266(45))

(AD-656734)

The results of a program of research in atomic and molecular physics by the molecular-beam method are briefly summarized. Work was done on the study of hyperfine structure in several

metastable atomic states, on a critical study of the hyperfine structure of indium, and on the hyperfine structure of a short-lived isotope of oxygen. The process of the production of metastable hydrogen atoms was investigated. Several investigations of hyperfine structures of atoms by optical-pumping and level-crossing techniques are reported. Publications resulting from the work are listed. TAB

N67-37170# Illinois Univ., Urbana. Dept. of Physics.
AN EXPERIMENTAL STUDY OF THE (He^3, dp) REACTION
R. A. Hoffswell, D. Jamnik, T. M. Noweir, and A. I. Yavin Aug. 1967 13 p refs
(Contract N00014-67-A-0305-005)
(AD-656735)

Results are presented of an experimental study of a sequential reaction on Zr90 of the type: Za + He3 to (Z + 1)A + 1 + d; (Z + 1)A + 1 to ZA + unstable-p. Data based on brief (He3, d unstable-p) experiments on Zr91 and Zr92 as well as C12 and O16 are also discussed. TAB

N67-37198*# Oak Ridge National Lab., Tenn.
NEUTRONS FROM $^9Be(\alpha,n)$ REACTION FOR $E\alpha$ BETWEEN 6 AND 10 KeV
V. V. Verbinski, F. G. Perey, J. K. Dickens, and W. R. Burrus 24 Aug. 1967 25 p refs
(NASA Order R-104(I))
(NASA-CR-88527; ORNL-TM-1891) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Absolute differential cross sections have been measured for the reaction $^9Be(\alpha,n)^{12}C$ leaving ^{12}C in its ground, first-excited, and second-excited states as a function of angle and alpha bombarding energy. The angular distribution for the ground-state (0+ state) transition changed from a fore–aft peaking at $E\alpha = 6.8$ MeV to a three-peaked angular distribution at $E\alpha = 9.9$ MeV. Similar behavior was observed for the second-excited-state transition (0+). The angular distribution for the first-excited-state transition (2+) displayed fore–aft peaking and was not sensitive to bombarding energy. A strong, low-energy neutron component, present at forward angles at all bombarding energies, can be accounted for by three- and four-body breakup reactions. It was determined that neutrons with energy ≤ 0.5 MeV account for $\approx 30\%$ of the total neutron production cross section from this reaction. Author

N67-37206# Stanford Univ., Calif.
ELECTRON COMPTON SCATTERING AT $\tau = 180°$
W. C. Barber, B. Gittelman, J. Selove (Pa. Univ.), D. Tompkins (Pa. Univ), and F. Forman (Pa. Univ.) [1967] 12 p refs Presented at the Intern. Conf. on Electromagnetic Interactions, Dubna, USSR, 6–15 Feb. 1967 Supported in part by AEC
(Contract Nonr-225(67))
(HELP-506; SLAC-PUB-307; AD-655451)

Previous experiments on high energy elastic pion nucleon scattering have demonstrated the existence of a peak in the differential cross section at 180 degrees. Because the experimental peak is much smaller and narrower than might be anticipated from the perturbation calculation, work was undertaken to explore the possibility that the attenuation of the backward peak is a general property of the Fermion propagator in the crossed channel, not just connected with strong interactions. The approach used involved the measurement of the Compton cross section for bremsstrahlung photons of maximum energy 500 MeV and 950 MeV. TAB

N67-37215*# Oak Ridge National Lab., Tenn.
REPRESENTATIVE RESULTS IN GRAPHICAL FORM FROM COMPUTER PRODUCTION RUNS OF THE LOW-ENERGY INTRANUCLEAR-CASCADE CALCULATION
Hugo W. Bertini, Barbara L. Bishop, and Miriam P. Guthrie Aug. 1967 91 p refs
(NASA Order R-104(I); Contract W-7405-ENG-26)
(NASA-CR-88495; ORNL-4128) CFSTI: $3.00/MF $0.65 CSCL 20H

This report contains an extensive set of graphs to illustrate the mass and energy dependence of results that were obtained from the output of computer production runs of a low energy intranuclear-cascade calculation. The nuclear reactions considered are those resulting from the interaction of neutrons and protons with energies from 50 to 400 MeV, and π^+ and π^- with energies from 50 to 300 MeV, with nuclei ranging from carbon to uranium. Plausibility arguments are given to explain some of the results. Author

N67-37238# Bonn Univ. (West Germany).
INVESTIGATION OF EXTRA-NUCLEAR EFFECTS IN ANGULAR CORRELATIONS Final Scientific Report, 1 Feb. 1965–1 Jun. 1967
E. Bodenstedt 1 Jun. 1967 5 p refs
(Grant AF-EOAR-65-59)
(Rept.-31-5-1967; AFOSR-67-1612; AD-655801)

The document is comprised of a very brief summary of the work accomplished (dealing largely with magnetic moments of excited nuclei), and a list of the three published papers resulting therefrom. TAB

N67-37241*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EQUATIONS FOR THE RAPID MACHINE COMPUTATION OF EQUILIBRIUM COMPOSITION OF AIR AND DERIVATIVES FOR FLOW-FIELD CALCULATIONS
G. Louis Smith, Wayne D. Erickson, and Mary R. Eastwood Washington, NASA, Oct. 1967 49 p refs
(NASA-TN-D-4103) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Equations are presented for the rapid computation of equilibrium air composition for use in flow-field calculations by electronic computer. The temperature-density domain with temperatures from 1500°K to 15,000°K and densities from 10^2 to 10^{-7} times standard atmospheric density is covered by four equilibrium air models which describe the composition in terms of mole fraction to an accuracy of better than 0.001. Equations are also presented for the computation of partial derivatives of mole fractions with respect to temperature, pressure, and elemental composition. Author

N67-37267# Naval Radiological Defense Lab., San Francisco, Calif.
DERIVATION OF THE GENERALIZED MASTER EQUATION FOR COMPOSITE PARTICLES
J. D. Mitchell and W. C. Schieve 10 Jul. 1967 46 p refs
(USNRDL-TR-67-78; AD-656586)

Generalized master equations for composite particles are derived. The methods of Girardeau are used to construct the appropriate representation of the density matrix for particles having internal degrees of freedom. The proper exchange symmetry between particles is described as an initial condition on the von Neumann-Liouville equation. The generalized master equations are then obtained for diagonal and off-diagonal matrix elements by a generalization of the projection technique of Zwanzig. The form of the equations is shown to be exactly the same as that obtained by Prigogine for structureless particles. The (lambda sq.)t approximation is discussed and it is shown that in this limit the particles will approach an equilibrium state in which exchange between the composite particles may be ignored. Author (TAB)

N67-37274 Wisconsin Univ., Madison. Theoretical Chemistry Inst.

POLAR (VELOCITY-ANGLE) FLUX CONTOUR MAPS FOR KBr FROM THE CROSSED BEAM REACTIONS K+HBr, DBr: EVIDENCE FOR BOTH FORWARD AND BACKWARD (C.M.) SCATTERING

Clyde Riley, Keith T. Gillen, and R. B. Bernstein 24 Jul. 1967 6 p refs Sponsored by AEC

(COO-1328-22; WIS-TCI-256X)

Polar (velocity-angle) KBr flux contour maps superimposed upon the nominal velocity vector triangle are presented. The maps show detailed observations of the velocity and angular distributions of KBr from the crossed beam reactions K+HBr and K+DBr, leading to a revised understanding of the reaction dynamics. The experiments indicate a very broad angular distribution of KBr in the center of mass system, with substantial forward and backward contributions. Previous velocity analysis experiments suggested that the KBr was scattered predominantly in the forward hemisphere of the center of mass system. L.S.

N67-37379# Oak Ridge National Lab., Tenn.

ELECTRONUCLEAR DIVISION Annual Progress Report, Period Ending Dec. 31, 1966

31 Dec. 1967 136 p refs

(Contract W-7405-ENG-26)

(ORNL-4122) CFSTI: HC $3.00/MF $0.65

Progress was made on many experiments, notably on proton–proton bremsstrahlung, on proton–proton interactions at very low energies, on shell-model structure studies through pickup of nucleons and through charge exchange, and on characterization of the optical model by the interaction of protons with complex nuclei. Work at high resolution was accomplished using the Elbek spectrometer. Theoretical work continued in close association. In the field of accelerator development, the experimental prototype 4-MeV Separated-Orbit Cyclotron was advanced in design, and earlier prototypes for the 50-MeV SOC were completed and tested. A new polarized source for the ORIC is under construction. Author (NSA)

N67-37395# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

UNFOLDING PARTICLE SIZE DISTRIBUTIONS

W. L. Nicholson and K. R. Merckx Mar. 1967 60 p refs

(Contract AT(45-1)-1830)

(BNWL-210) CFSTI: HC $3.00/MF $0.65

The estimation of a particle size distribution from a data histogram is treated in terms of a general framework that extends previous developments. The method, at least in principle, can be applied to any complex particle that can be sized in terms of a single characteristic dimension. A sectioning or sampling process must be used to produce a particle intersection that can also be sized with a single characteristic measurement. The precision of the process is estimated with a standard deviation estimate for each particle size in the distribution. The method can be used to estimate distribution of sizes of voids induced by fission gases in irradiated U. A Fortran IV program called Unfold, for analysis of the frequency data collected on a particle size analyzer, is presented. NSA

N67-37402# Los Alamos Scientific Lab., N. Mex.

OFFSHELL $^1S_0$ PROTON–PROTON SCATTERING MEDIATED BY A SOFT CORE POTENTIAL

John E. Brolley and L. Kent Morrison (Wash. Univ., Seattle) 2 Jun. 1967 9 p refs

(Contract W-7405-ENG-36)

(LA-3706-MS) CFSTI: HC $3.00/MF $0.65

A soft-core potential was applied to offshell $^1S_0$ p–p scattering at low energy. The Coulomb field was assumed to be screened by the electrons of the hydrogen atoms in the target and was therefore cut off at the radius of the hydrogen atom. Cross sections and phase shifts were calculated and were compared with experimental data. NSA

N67-37403# Princeton Univ., N. J. Elemetary Particles Lab.

COMPARISON OF THE K^+ AND K^- DECAY RATES INTO THE τ AND $K\mu_2$ MODES Technical Report, Jun. 1965–Jul. 1967

William T. Ford (Ph.D. Thesis) 6 Jul. 1967 145 p refs

(Contract N0014-67-A-0151-0001)

(TR-43; AD-656490)

In an experiment at the Brookhaven AGS the decay rates of charged K mesons into the tau mode (K(+) to 2pi(+) + pi(-), K(-) to 2pi(-) + pi(+)) were measured in order to test the equality of the tau(+) and tau(-) rates. A difference between these rates would constitute a violation of CP invariance. At the same time the K(+) and K(-) decay rates into the K-mu2 mode (K(+) to mu(+) + muon-neutrino, K(-) to mu(-) + muon-nutrino) were also compared, as a test of CPT invariance. The K mesons, identified with a Cerenkov counter, were allowed to decay in flight over a well-defined region at the end of which were detectors for the charged secondaries. To detect the tau decays an array of eight triangular scintillation counters arranged in an octagon was used, with the requirement that all three pions give a count. A second bank of counters placed behind an iron absorber detected the muons from K-mu2 decays. The result for the ratio of tau(+) and tau(-) decay rates is (Gamma(+)/Gamma(-))-tau -1 = -0.0004 + 0.0021 or -0.0021, consistent with CP invariance. The absolute tau decay rate is Gamma-tau = (4.496 plus or minus 0.030) x 1000000/sec. For K-mu2 decay the result of the rate comparison is (Gamma(+)/Gamma(-))-mu2 -1 = 0.0054 plus or minus 0.0041, in agreement with zero, as predicted by CPT invariance. Author (TAB)

N67-37423# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

COMPILATION OF DOUBLY DIFFERENTIAL CROSS SECTIONS AND THE SCATTERING LAW FOR H_2O AND D_2O AT 299°K AND FOR H_2O AT 268°K

O. K. Harling Jun. 1967 125 p refs

(Contract AT(45-1)-1830)

(BNWL-436) CFSTI: HC $3.00/MF $0.65

A compilation of slow neutron inelastic scattering cross sections is presented for H_2O at 268 and 299°K and for D_2O at 299°K. The doubly differential cross sections and, from these, the Egelstaff scattering law were obtained from measurements made with the Battelle rotating-crystal time-of-flight spectrometer. Maximum energy transfers by downscattering at 0.6, 0.21, and 0.6 eV with wave vector $\bar{k} = \bar{P}/\hbar$ transfers up to 32, 9.5, and 32Å were used, respectively, with H_2O, D_2O, and light ice. NSA

N67-37433# Los Alamos Scientific Lab., N. Mex.

CALIBRATION OF TANDEM ANALYZING MAGNET

Norman H. Magee, Thomas G. Masterson, and Stanley L. Whetstone 3 Jul. 1967 19 p refs

(Contract W-7405-ENG-36)

(LA-3699) CFSTI: HC $3.00/MF $0.65

A particle scattering method has been used to help establish the energy calibration of the analyzing magnet at the LASL tandem Van de Graaff. The method and experimental procedures are described in some detail and a fairly complete presentation of the results is given. A least-squares fit to a large number of values obtained for the magnet constant K defined for protons by $I = K[E(1+E/2M]^{1/2}$ gives $K = (8.057 \pm 0.004) - (9 \pm 18)10^{-10}I$ in the proton energy range of 10 to 20 MeV. Although K is found

to be approximately constant over the range of the measurements, the value obtained does not agree with the value, 6.065±0.002, derived from precise measurements of the $^{27}Al(p,n)$ threshold at 5.797 MeV. Author (NSA)

N67-37436# Los Alamos Scientific Lab., N. Mex.
Li-6 and Li-7 DATA IN THE ENDF/B FORMAT
M. E. Battat, D. J. Dudziak, and R. J. La Bauve 26 Jun. 1967 39 p refs
(Contract W-7405-ENG-36)
(LA-3695-MS) CFSTI: HC $3.00/MF $0.65

At the Cross Section Evaluation Working Group (CSEWG) Meeting on June 9–10, 1966, at Brookhaven National Laboratory, the Los Alamos Scientific Laboratory was assigned the responsibility of preparing the data for the isotopes ^{6}Li and ^{7}Li for the first version of the Evaluated Nuclear Data File/B (ENDF/B) tape. These data were assembled in the ENDF/B format and were sent to the Cross Section Evaluation Center (CSEC) at Brookhaven National Laboratory. Most of the data are from the AWRE data file originated by K. Parker of Aldermaston. Values for $\bar{\mu}_{LAB}$ and ξ, along with Legendre coefficients for the elastic scattering angular distributions, were received from H. Alter of Atomics International. Plots of the original AWRE cross section data converted to the ENDF/B format are presented. The ENDF/B listings for the ^{6}Li and ^{7}Li data, as they appeared on the first version (approximately February 1967) of the ENDF/B tape, are shown. Author (NSA)

N67-37478# Imperial Coll. of Science and Technology, London (England).
FEYNMAN DIAGRAMS FOR UNITARY REPRESENTATIONS OF SL(2,C)
K. Koller Jun. 1967 31 p refs
(Grant AF-EOAR-67-12)
(AFOSR-67-1632; AD-655733)

Weinbergs derivation of Feynman rules for finite dimensional representation of the Lorentz group is generalized for massive particles to infinite dimensional irreducible representations of the Lorentz group. Following Feldman and Matthews, local and causal infinite dimensional fields, quantised by a commutator, are written down for irreducible unitary representations of the principal series of SL(2,C). Feynman rules for those infinite dimensional fields are stated and three point functions and pole diagrams are given explicitly for arbitrary unitary irreducible representations of the principal series of SL(2,C). Author (TAB)

N67-37482# Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center.
ON THE TREATMENT OF HYDROGEN SCATTERING IN MULTIGROUP MONTE CARLO CRITICALITY CALCULATIONS
G. E. Whitesides and N. F. Cross [1966] 7 p refs Presented at the 13th Ann. Meeting of the Am. Nucl. Soc., San Diego, Calif.
(Contract W-7405-ENG-26)
(K-DP-2252; CONF-670602-17) CFSTI: HC $3.00/MF $0.65

Two methods of treating scattering by hydrogen in criticality calculations using the Monte Carlo method are briefly discussed. The results of some calculations of multiplication constants for a variety of experimentally critical systems are presented. NSA

N67-37489# Imperial Coll. of Science and Technology, London (England). Dept. of Physics.
U(6,6) AND SUPERCONVERGENT SUM RULES FOR MESON–BARYON SCATTERING
H. F. Jones and M. D. Scadron Jul. 1967 20 p refs
(Grant AF-AFOSR-67-12)
(ICTP/67/7; AFOSR-67-1704; AD-656001)

Superconvergent sum rules are derived for Pi + N* to Pi + N*, two of which agree with U(6,6) when saturated by N and N* poles in the equal mass limit. Saturation for physical masses gives gamma-N* ≈ 84 MeV. It is pointed out that those sum rules which agree with U(6,6) for Pi + N to Pi + N* and Pi + N* to Pi + N* do so also for all analogous strange-particle reactions. The special status of these sum rules is discussed. Author (TAB)

N67-37494# Oak Ridge National Lab., Tenn.
PHYSICS DIVISION ANNUAL PROGRESS REPORT, PERIOD ENDING DECEMBER 31, 1966
P. H. Stelson, ed. May 1967 175 p refs
(Contract W-7405-ENG-26)
(ORNL-4082) CFSTI: HC $3.00/MF $0.65

Abstracts of papers on nuclear physics reactions are presented. Subject areas covered include: 1) proton and neutron scattering cross sections, 2) Coulomb excitation, 3) neutron capture, 4) dipole moments, 5) fission, 6) emission, 7) nuclear structure, 8) resonance, 9) gamma ray spectra, 10) optical models for particles, 11) shell model calculations, 12) electron spin motion, and 13) radiative transitions in target isotopes. Other experimental efforts relating to these areas of nuclear particles are also reported. L.S.

N67-37497# Atomic Energy Commission, New York. Health and Safety Lab.
TABULATED VALUES OF EXPERIMENTALLY DETERMINED DIFFERENTIAL ENERGY AND ANGLE SPECTRA FOR ^{137}Cs GAMMA RAYS IN WATER AND AIR
Mary Alberg, Harold Beck, Keran O'Brien, and James E. McLaughlin Dec. 1966 78 p
(HASL-187) CFSTI: HC $3.00/MF $0.65

In the 1967 Nuclear Science and Engineering article, "An Investigation of Differential Energy and Angle Spectra for ^{137}Cs Gamma Rays in Water and Air," the measurements and analyses leading to the γ-ray energy and angle spectra in water and a condensed air-like medium were described. Tabulated values of these spectra at the angles and penetration distances that were studied are presented. Also included are the differential energy spectra that were obtained by an integration of the results over all angles, and interpolations of the water spectra that were used for comparison with the spectra obtained in the air-like medium, a 6.15% solution of NaOH. Author (NSA)

N67-37538# California Univ., Livermore. Lawrence Radiation Lab.
CONTRACTED BASIS SET ANALYTIC SELF-CONSISTENT FIELD WAVE FUNCTIONS FOR TRANSITION METAL ATOMS
A. M. Karo, F. McMurphy, and R. K. Nesbet (IBM, San Jose, Calif.) 17 May 1967 28 p refs
(Contract W-7405-ENG-48)
(UCRL-50260) CFSTI: HC $3.00/MF $0.65

Self-consistent field wave functions for the transition metal atoms in their neutral ground state configurations have been obtained that are close approximations to conventional, restricted Hartree–Fock functions. The atomic orbitals have been expanded in terms of linear combinations of orbitals from a basis set of eleven exponential Slater-type functions. Both the linear expansion coefficients and the nonlinear exponential parameters have been optimized by means of standard variational procedures. Results show that from 80 to 90% of the energy improvement between simple Slater orbitals with nonoptimized screening parameters and the true Hartree–Fock results is obtained through this limited, optimized basis. Author

N67-37595# Los Alamos Scientific Lab., N. Mex.
MEDIUM-ENERGY PHYSICS PROGRAM Quarterly Status Report, Period Ending Apr. 30, 1967
31 May 1967 47 p refs
(Contract W-7405-ENG-36)
(LA-3712-MS) CFSTI: HC $3.00/MF $0.65

The medium-energy physics program at LASL which deals with the new Los Alamos Meson Physics Facility is discussed. The topics covered the injector system, accelerator structures, rf power sources, accelerator control and instrumentation, accelerator physics, project scheduling, and facilities planning. NSA

N67-37621*# Oak Ridge National Lab., Tenn. Radiation Shielding Information Center.
COMPARISONS OF RESULTS OBTAINED WITH SEVERAL PROTON PENETRATION CODES
W. Wayne Scott and R. G. Alsmiller, Jr. Jul. 1967 27 p refs
(NASA Order R104(10); Contract W-7405-ENG-26)
(NASA-CR-88880; ORNL-RSIC-17) CFSTI: HC $3.00/MF $0.65
CSCL 18F

Comparisons of the results obtained for a hypothetical problem with four different proton penetration codes included in the Radiation Shielding Information Center's code collection are presented. All the codes include secondary-particle production and transport in some approximation. The hypothetical problem was to find the dose as a function of depth in tissue resulting from a typical solar-flare proton spectrum normally incident on an infinite slab shield which is followed by the slab of tissue. The tissue was assumed to be 30 g/cm^2 thick. The solar proton spectrum was taken to be exponential in rigidity with a characteristic rigidity, P_0, of 100 MV and was normalized to 10^9 protons/cm^2 with energy >30 MeV. Graphs comparing both the total and the various secondary-particle contributions to the dose for aluminum and iron shields are presented. Definite inconsistencies between some of the codes are apparent. Author (NSA)

N67-37632# Atomic Energy Commission Research Establishment, Lucas Heights (Australia).
ABSOLUTE ACTIVITY MEASUREMENTS OF MOLYBDENUM 99 AND 4π-γ ION CHAMBER MEASUREMENTS OF TECHNETIUM 99m AND OF MOLYBDENUM 99 WITH INGROWN TECHNETIUM 99m
G. C. Lowenthal, J. Robson, and R. Deshpande (Bhabha Atomic Res. Centre, Trombay, India) Feb. 1967 14 p refs
(AAEC/TM-374) CFSTI: HC $3.00/MF $0.65

The activity of molybdenum 99 freshly separated from technetium is absolutely measured to ± 1.8 percent by 4$\pi\beta$-γ coincidence counting. Internal conversion effects are allowed for and the completeness of the separation is checked from the growth rate of technetium 99m activity as measured in a 4π gamma ionization chamber. The chamber has been calibrated for molybdenum 99 with ingrown technetium 99m and for pure technetium 99m, and serves for routine activity measurements of solutions of these nuclides to an accuracy of ± 3 percent. Author

N67-37650# Atomics International, Canoga Park, Calif.
COMPILATION, EVALUATION, AND REDUCTION OF NEUTRON DIFFERENTIAL SCATTERING DATA, VOLUME IV
R. W. Campbell, S. K. Davis, H. Alter, C. L. Dunford, and R. F. Berland 3 Apr. 1967 288 p refs
(NAA-SR-11980, Vol. IV) CFSTI: HC $3.00/MF $0.65

A compilation is given of the angular distributions of elastically scattered neutrons, based on available experimental data, for isotopes in the mass range $2 \leq A \leq 244$. These data were analyzed and reduced into a form convenient for use in digital computer calculations. The elastic differential scattering data are represented by expansions in a finite series of Legendre polynomials with energy-dependent coefficients in the center-of-mass coordinate system. A listing of the Legendre coefficients for all angular distributions, as well as plots of selected data, are included. The primary source of experimental data was report BNL-400, second edition. NSA

N67-37682# Brookhaven National Lab., Upton, N. Y. Accelerator Dept.
EMPIRICAL FORMULAS FOR PARTICLE PRODUCTION IN P–Be COLLISION BETWEEN 10 AND 35 BeV/c, PART II
J. R. Sanford and C. L. Wang 1 May 1967 32 p refs
(BNL-11479, Pt. II) CFSTI: HC $3.00/MF $0.65

Formulas of the same type as those previously presented for meson (π) multiplicities are given for meson (K) and antiproton production. The calculated momentum spectra for mesons (K^+), (K^-), and antiprotons are plotted and presented with the experimental data. Also the multiplicities, mean secondary and transverse momenta, and inelasticities are given. Author (NSA)

N67-37701# California Univ., Berkeley. Lawrence Radiation Lab.
PROGRAM BRAGG—A FORTRAN-IV PROGRAM FOR CALCULATING BRAGG CURVES AND FLUX DISTRIBUTIONS
Gerald M. Litton 24 Feb. 1967 68 p refs
(Contract W-7405-ENG-48)
(UCRL-17391) CFSTI: HC $3.00/MF $0.65

The BRAGG code was used to calculate Bragg curves and number–distance curves for a beam of ions of arbitrary atomic number, atomic weight, and energy, incident on an absorber. The absorber was assumed to be homogeneous, but could consist of an arbitrary number of components, each specified by atomic number, atomic weight, and atomic density. The geometry considered was a broad, well-collimated beam incident on a slab whose transverse dimensions were large compared to the distance travelled by the ions in the absorber. The calculation took into account ionization energy loss, energy straggling, nuclear attenuation, and multiple scattering; but energy deposition from secondary particles was neglected. NSA

N67-37712 Montreal Univ. (Quebec).
REPORT OF ACTIVITIES NUMBER 1, 1964–1966 [RAPPORT D'ACTIVITE NO. 1 1964–1966]
Apr. 1967 25 p refs In FRENCH
(LPN-UM-5)

Activities of the nuclear physics laboratory of the University of Montreal are reported for the period 1964 to 1966. Work was concentrated in three areas: research programs; plans and construction of the building of nuclear physics; and summary study reports on theoretical and nuclear physics. R.U.

N67-37721# Brookhaven National Lab., Upton, N. Y. Accelerator Dept.
A METHOD FOR THE CALCULATION OF BEAM ORBITS IN THE AGS
U. Vogel 1 Jun. 1967 17 p refs
(Contract AT(30-2)-GEN-16)
(BNL-11469) CFSTI: HC $3.00/MF $0.65

A method is described by which the beam orbits in the AGS can be calculated by a computer when the beam deflecting fields are assumed to be known. NSA

N67-37730# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.

NEGATIVE PION CAPTURE BY CARBON AND TETRANEUTRON NUCLEI [ZAKHVAT OTRITSATEL'NYKH π-MEZONOV YADRAMI UGLERODA I TETRANEITRON]

Yu. A. Batusov, S. A. Bunyatov, V. M. Sidorov, and V. A. Yarba 1967 8 p refs In RUSSIAN

(JINR-P1-3306)

Negative pion capture by photoemulsion nuclei with the production of ^{8}Li and ^{8}B was investigated. One-prong events were analyzed in order to separate the reaction $\pi^- + {}^{12}C \rightarrow {}^{8}B + {}^{4}n$. The relative probability of the reaction R_1 with the tetraneutron production in the capture of mesons (π^-) by carbon nuclei is found to be smaller than 2.6.10. Author (NSA)

N67-37768# Oak Ridge National Lab., Tenn. Nuclear Div.

MONTE CARLO CALCULATIONS OF THE NEUTRON FLUX WITHIN A $^{10}B_4C$ SHELL

R. M. Freestone, Jr. 9 Jun. 1967 29 p refs

(Contract W-7405-ENG-26)

(ORNL-TM-1816) CFSTI: HC $3.00/MF $0.65

A Monte Carlo code, 05R, was used to study the transport of neutrons through a nearly spherical $^{10}B_4C$ shell. Such shells are often used to shield neutron detectors against the intense background of thermal neutrons associated with reactor or reactor-like neutron fluxes. An aluminum disk simulated a solid-state detector within the shell. Calculations were made for isotropic monoenergetic neutrons having energies of 0.5, 1, 2, 4, 6, 8, 10, 12, and 14 MeV, for an isotropic fission spectrum source, and for comparison purposes, for a 4-MeV normal beam source. The results indicate that only a small distortion of the incident spectral shape is created by passage through the shell. The effect seems to be confined to incident neutron energies below 2 MeV. The degree of isotropy of the incident flux, however, importantly affects the absolute fraction of neutrons reaching the detector. Author

N67-37806# Oak Ridge National Lab., Tenn.

SPECTROSCOPIC STUDY OF THE PROTON GROUND STATE CONFIGURATIONS IN THE ZIRCONIUM ISOTOPES

Barry Mason Preedom (Ph.D. Thesis—Tenn. Univ., Knoxville) Jun. 1967 109 p refs

(Contract W-7405-ENG-26)

(ORNL-TM-1880) CFSTI: HC $3.00/MF $0.65

A distorted-wave analysis was made of (d,^{3}He) data to provide information concerning the structure of the nucleus. It was found that the DW calculations predicted the shape of the observed proton transfers very well. The calculations could also predict the specific variations in the angular distributions that were observed for different $j(1\pm1/2)$ transfers. Because of the unique DW predictions for each assumed l and j, it was possible to assign spins and parities to the different states in the residual nuclei. Uncertainties exist when the DW analysis is used to obtain spectroscopic information concerning the absolute values for the populations of different configurations. The uncertainty arising from the lack of specific knowledge about the bound-state wave function was investigated. It was seen that the magnitude of the predicted angular distributions, and thus the extracted spectroscopic strengths, are quite sensitive to the parameters of the bond-state well. The uncertainty involved in selecting a single parametric set for this well is reflected in the values of the absolute spectroscopic factors. Even with this difficulty, the magnitude of the values are within 30% of the sum-rule limits. To display the systematics of the data, relative spectroscopic factors were presented for each isotope. Uncertainties in these values are dependent on the ability of the DW theory to correctly predict the (n,1,j) and Q-dependence, and on the relative experimental errors which are mainly statistical in nature. It was found that these relative spectroscopic factors were consistent from one isotope to another. By using the relative values for the spectroscopic strengths, this work can be interpreted in terms of a simple shell model picture. It was found that the admixture of the $(2p_{1/2})^2$ and $(1g_{9/2})^2$ proton configurations changes as $2d_{5/2}$ neutrons are added. The relative amounts of the mixture are 64% $(2p_{1/2})^2$ and 36% $(1g_{9/2})^2$ in the ground state of ^{90}Zr. The $(2p_{1/2})^2$ mixture decreases to 55% for ^{92}Zr and then increases to 66% for ^{94}Zr and 86% in the ground state of ^{96}Zr. Thus, it is concluded that the $2d_{5/2}$ neutron shell has an effect on the proton configuration through the p-d and g-d proton–neutron interactions. The observed changes in the $(2p_{1/2})^2$ and $(1g_{9/2})^2$ proton admixture provide a measure of the relative strengths of these interactions. Author (NSA)

N67-37814# California Univ., Berkeley. Lawrence Radiation Lab.

$He^3(He^3,t)3p$ AT 44 MeV

T. A. Trombrello (Calif. Inst. of Tech., Pasadena), and R. J. Slobodrian Mar. 1967 10 p refs

(Contract Nonr-220(47))

(TID-23841; AD-650970) CFSTI: HC $3.00/MF $0.65

Triton spectra from the reaction $^{3}He(^{3}He,t)3p$ were measured at a bombarding energy of 44 MeV for laboratory angles between 6° and 25°. These spectra are quite featureless and show no indication of either a 3p final state interaction or of a strong sequential decay mode. Author (NSA)

N67-37845# California Univ., Berkeley. Lawrence Radiation Lab.

PHYSICAL INTERPRETATION OF STATIC MODEL PARAMETERS

F. Landis Markley (Ph.D. Thesis) 5 Apr. 1967 59 p refs

(Contract W-7405-ENG-48)

(UCRL-17502) CFSTI: HC $3.00/MF $0.65

It is shown that an approximation to the static crossing matrix leads to a soluble model for the p_{11} and p_{33} πN scattering amplitudes in which the parameters are related to forces due to particle exchanges in the t-channel. Reasonable values of these forces give the nucleon bound state and the Δ resonance in good agreement with experiment. Properties of the model are further investigated. Author (NSA)

N67-37883# Oak Ridge National Lab., Tenn. Neutron Physics Div.

A FORMALISM FOR THE CALCULATION OF NEUTRON-CAPTURE GAMMA-RAY SPECTRA

K. J. Yost 9 Jun. 1967 25 p refs

(Contract W-7405-ENG-26)

(ORNL-TM-1867) CFSTI: HC $3.00/MF $0.65

A methodology for the calculation of neutron-capture gamma spectra in light (A<70), magic, and near-magic nuclei was developed. Nuclear spin and parity effects relative to radiative transition probabilities are explicitly accounted for. Means are provided for allowing electric and magnetic dipole and quadrupole transitions, as well as spin-dependent spin-branching ratios. Author (NSA)

N67-37870# Mound Lab., Miamisburg, Ohio.

STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION, OCTOBER–DECEMBER 1966

31 Dec. 1966 30 p refs

(Contract AT(33-1)-GEN-53)

(MLM-1390) CFSTI: HC $3.00/MF $0.65

About 0.03 liter/day of 8% ^{21}Ne was withdrawn from the side port of a 4-column, four-stage, neon cascade system. The total neon in the ^{22}Ne product stream increased to 99% after recycle from the 3-column tube bundle was discontinued. Until

8% ^{21}Ne feed was no longer available for the 3-column tube bundle, 0.01 liter/day of over 25% ^{21}Ne was separated. The system was then used to enrich natural abundance neon to 5% ^{21}Ne while a sufficient inventory of 5% ^{21}Ne feed from the 4-column cascade was being accumulated. The location of the ^{21}Ne peak was sensitive to the relative amounts of ^{20}Ne and ^{22}Ne in the feed. From a series of xenon–krypton separations on a chromatographic column of 20-cm^2 cross section and packed with molecular sieve 13X, the optimum carrier gas flow was determined to be 9 to 17 liters/min. An argon–krypton separation was made at a column temperature of 87.3°K. Feed loads of 500 ml were run with a 96% recovery of the krypton. The product was 99.95% krypton. ^{124}Xe enriched to 1, 5, and 10% was withdrawn from an eight-stage, xenon, thermal diffusion tube bundle cascade. The 1% ^{124}Xe was withdrawn for a high concentration of ^{129}Xe (≈60%). Comparison of experimental and theoretical results for the neon–xenon system are reported for 55°, 100°, 200°, and 300°C. An extensive series of experiments to determine experimental values of thermal-diffusion column transport coefficients for ^{20}Ne–^{22}Ne separation was completed. Column transport coefficients were calculated for krypton from experimental static and flow separation data. Author (NSA)

N67-37871# Paris Univ., Orsay (France).
RELATIVISTIC TREATMENT OF MUON CAPTURE IN DEUTERIUM. APPLICATION TO THE DETERMINATION OF NEUTRON–NEUTRON SCATTERING LENGTH AND EFFECTIVE RANGE
E. Cremmer May 1967 23 p refs
(NP-16819)

A relativistic calculation of muon capture in deuterium is performed. The important effect of hyperfine structure is treated relativistically. The aim of this work is a determination of neutron–neutron scattering length and effective range. Vertex functions are used to describe the proton–neutron–deutron vertex and the Omnès method to compute the final state interaction. It is shown that an accuracy of 2.5% in spectrum and capture rate must allow a determination of r_{0s} and a_s with an accuracy of, respectively, ±0.2 Fermi and ±0.7 Fermi. Author (NSA)

N67-37889# Columbia Univ., New York.
A STUDY OF ^{48}Ti, ^{48}Ti, ^{50}Cr, AND ^{54}Fe USING TRIPLE CORRELATIONS
David J. Church (Ph.D. Thesis) 1967 107 p refs
(TID-23854) CFSTI: HC $3.00/MF $0.65

A number of excited states in the nuclei ^{46}Ti, ^{48}Ti, ^{50}Cr and ^{54}Fe were studied by means of triple angular correlation measurements. The excited states were produced by proton inelastic scattering. Coincident gamma-ray angular correlation measurements were made on the cascade from the state being studied, through the first excited state. The populations of the magnetic substates of the initial state in the cascade were treated as unknowns in the analysis of the experimental data. The 2.01-, 2.61-, and 2.96-MeV states in ^{48}Ti were studied at an incident proton energy of 5.00 MeV. The experimental results for the 2.01-MeV state were consistent with a previous J=4 assignment. The 2.61-MeV state was unambiguously assigned J=0. The 2.96-MeV state has either J=2 or J=3, with a mixing ratio for the decay to the 0.89-MeV state of $\delta = -1.07 \pm 0.15$ for J=2, or $\delta = +0.26 \pm 0.05$ for J=3. The 3.00-MeV state in ^{48}Ti was studied at an incident proton energy of 4.75 MeV. The experimental results permitted an unambiguous spin assignment of J=0 for the 3.00-MeV state. The 1.90-, 2.94-, and 3.18-MeV states in ^{50}Cr were studied at an incident proton energy of 5.56 MeV. The experimental results for the 1.90-MeV state were consistent with a previous J=4 assignment, and definitely exclude a recent J=0 assignment to this state. The spins of the 2.94- and 3.18-MeV states were determined to be either J=2 or J=3. Both of these states were recently assigned J=2. The mixing ratios determined by the present work for the J=2 assignment are as follows. The mixing ratio for the transition from the 2.94-MeV state to the 0.79-MeV state is $\delta = -0.17 \pm 0.05$. The mixing ratio for the transition from the 3.18-MeV state is $\delta = +0.20 \pm 0.05$. The 2.56-MeV state in ^{54}Fe was studied at an incident proton energy of 5.15 MeV. The experimental results permitted an unambiguous spin assignment of J=0 for the 2.56-MeV state. Author (NSA)

N67-37908# Joint Inst. for Nuclear Research, Dubna (USSR).
SOME METHODICAL PROBLEMS OF $K^+p \rightarrow KN_\pi$ REACTION INVESTIGATION AT 3.5 GeV/c IN THE CERN 81 cm LIQUID HYDROGEN BUBBLE CHAMBER [NEKOTORYE METODICHESKIE VOPROSY ISSLEDOVANIYA REAKTSII $K^+p \rightarrow KN_\pi$ PRI IMPULSE 3.5 GeV/c V 81 CM KHIDKOVODORODNOI PUZYR'KOVOI KAMERE TSERN'A]
A. M. Moissev and V. A. Yarba 1967 38 p refs In RUSSIAN
(JINR-P1-3313)

The reactions $K^+p \rightarrow KN_\pi$ at the primary K^+ meson momentum of 3.5 GeV/c were investigated on the photographs of the 81-cm liquid hydrogen bubble chamber. The procedure of data processing used and the system of programs of the track chamber division are described. The problems of the event selection and inclusion of the ambiguously interpreted events into statistics are also discussed. Author (NSA)

N67-37909# Joint Inst. for Nuclear Research, Dubna (USSR).
THE DECAY $^{160}Tb \rightarrow ^{160}Dy$ [ISSLEDOVANIE RASPADA $^{160}Tb \rightarrow ^{160}Dy$]
Ya. Vrzal, P. Galan, T. I. Galanova, Ya. Liptak, Ya. Urbanets et al 1967 30 p refs In RUSSIAN
(JINR-P6-3312)

The gamma spectrum of ^{160}Tb was investigated using two germanium semiconductor detectors. The absolute intensities and multipolarities of γ transitions in a ^{160}Dy nucleus were investigated. A conclusion was drawn about the two-quasiparticle nature of the 1264.4-keV energy level, and an assumption was made about the existence of rotational band on this state. Experimental data are compared with the predictions of different nuclear models. Author (NSA)

N67-37910# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
THE CUT-OFFS IN THE COMPLEX L-PLANE AND THE BEHAVIOR OF INELASTIC PROCESS CROSS SECTIONS [RAZREZY V KOMPLEKSNOI L-PLOSKOSTI I POVEDENIE SECHENI I NEUPRUGIKH PROTSESSOV]
Dao Wong Duc, Nguyen Van Hieu, and A. N. Tavkhelidze 1967 9 p refs In RUSSIAN Submitted for publication
(JINR-P2-3337)

The role of cut-offs in the asymptotic behavior of the scattering amplitudes is considered. It is shown that the differential cross section behavior of a number of inelastic processes essentially depends on the presence of cut-offs. Author (NSA)

N67-37912# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy.
ON SOME CORRELATION PROPERTIES OF NEUTRAL AND ANTI-KAON PAIRS [O NEKOTORYKH KORRELYATSIONNYKH SVOISTVAKH NEITRALNII I ANTIKAON PAR]
V. L. Lyuboshits, E. O. Okonov, and M. I. Podgoretskii 1967 8 p refs In RUSSIAN
(JINR-P2-3310)

Correlations in strong decays of a $K^{0*}\bar{K}^{0*}$ pair into neutral particles were considered. It is shown that if CPT is not preserved, the $K^0\bar{K}^0$ pair can decay according to the K_LK_S scheme at even orbital moments. Author (NSA)

N67-37913# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
GENERALIZATION OF THE CABIBBO–RADICATI RELATION TO THE CASE OF NONMINIMAL ELECTROMAGNETIC INTERACTIONS
V. Z. Baluni 1967 9 p refs
(JINR-E2-3339)

The modified Cabibbo–Radicati relation is derived taking into account possible nonminimality of the electromagnetic interactions. It is assumed only that the invariant amplitude vanishes at high energies. Author (NSA)

N67-37915# Akademiya Nauk URSR, Kiev.
ON SUMMATION OF THE CONTRIBUTIONS FROM THE FEYNMAN DIAGRAMS. AN EXISTENCE THEOREM II
D. Ya. Petrina 1967 28 p refs
(ITF-67-6)

It is shown that a solution to a previously considered equation $F=g\bar{A}F+F^0$ [Petrina, D. Ya., preprint ITF-67-3,K., Naukova Dumka, 1967] for which a solution represented by an iteration series converging in the norm of space H was shown for sufficiently small $|g| < g_0$, exists for arbitrary complex g of the complex g-plane with the cut $|\mathrm{Re}g| \geq g_0$, $\mathrm{Im}g=0$. This result is obtained by making use of the self-adjoint character of the linear operator $\bar{A}$. NSA

N67-37917# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
ANGULAR CORRELATION OF γ-QUANTA PRODUCED BY THE STOPPING OF NEGATIVE PIONS IN HYDROGEN [UGLOVAYA KORRELYATSIYA γ-KVANTOV OBRAZUYUSHCHIKHSYA PRI OSTANOVKE π^- MEZONOV V VODORODE]
I. M. Vasilevskii, V. V. Vishnyakov, A. F. Dunaitsev, Yu. D. Prokoshkin, V. I. Rykalin et al 1967 67 p refs In RUSSIAN
(JINR-P1-3285)

The angular correlation of γ-quanta emitted in the capture of stopped mesons (π^-) in hydrogen is measured. The measurements were performed by using the scintillation and gas-discharge counters hodoscope. The value of mass difference of charged and neutral mesons (π^-) was found to be (4.6034 ± 0.0052) MeV/c^2. The upper probability limit of the production of the second neutral meson (π), which has a mass in the range of 135 to 138 MeV/c^2, was determined. Author (NSA)

N67-37929# Joint Inst. for Nuclear Research, Dubna, (USSR). Lab. of Theoretical Physics.
UNITARY REPRESENTATIONS OF THE LORENTZ GROUP AND FUNCTIONS WITH SPIN
M. A. Liberman, Ya. A. Smorodinskii, and M. B. Sheftel 1967 26 p refs
(JINR-E2-3294)

Irreducible unitary representations of the Lorentz group are constructed, which are realized on the space of functions, defined on the direct product of the two spaces—a hyperboloid (with an infinite-dimensional representation) and a sphere (with a finite-dimensional spin representation). These functions form the basis for the integral representations of scattering amplitudes. They also form the complete set of functions in which an arbitrary solution of relativistic field equations expands for the fields with a fixed spin. Author (NSA)

N67-37930# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy.
ON A POSSIBLE EFFECT OF WEAK INTERACTION ON THE MOLECULAR LEVEL STRUCTURE [O VOZMOZHNOM VLIYANII SLABOGO VZAIMODEISTVIYA NA STRUKTURU MOLEKULYARNYKH UROVNEI]
V. A. Onishchuk 1967 9 p refs In RUSSIAN
(JINR-P4-3299)

The estimates of the value of mixing of Λ-dipole levels of diatomic molecules are given for the case when there exists a weak interaction, which does not preserve the parity, through neutral current as well as when the electrons and nucleons have electric dipole moments. Author (NSA)

N67-37931# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of the Theoretical Physics.
LECTURES ON RELATIVISTIC KINEMATICS OF ONE-PARTICLE STATES [LEKTSII PO RELYATIVISTSKOI KINEMATIKE ODNOCHASTICHNYKH SOSTOYANII]
V. P. Shelest 1967 31 p refs In RUSSIAN
(JINR-P2-3333)

An apparatus of transformation of one-particle states under the operation of the Lorentz rotations, as well as of space ones, is considered. This apparatus is applied to perform the transformations from the physically important $P_z \to \infty$ frame of reference to the Breit frame. Author (NSA)

N67-37936# Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies.
ON THE REGGE SYMMETRIES OF THE 3J SYMBOLS OF Su(2)
G. Flamand [1966] 17 p refs
(LPTHE-TH-183)

The symmetries of the 3j symbols of SU(2) are fitted into a broader group theory framework. The 3j symbols of SU(2) are identified with certain 3j symbols of SU(3). Viewed as SU(3) properties, their Regge symmetries are nothing but ordinary permutation symmetries. Author (NSA)

N67-37937# Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Center d'Etudes Nucleaires.
ABSOLUTE MEASUREMENT OF A STANDARD THERMAL-NEUTRON FLUX USING GOLD-DETECTOR ACTIVATION [MESURE ABSOLUTE D'UN FLUX ETALON DE NEUTRONS THERMIQUES PAR ACTIVATION DE DETECTEURS D'OR]
Yves Paternot Feb. 1967 100 p refs In FRENCH
(CEA-R-3166)

The density of neutrons in a standard stocking is determined between the zero-energy and the cut-off energy of 1 mm thick cadmium unit using a gold detector. Its absolute activity is measured using a 4 π counter calibrated for 4 π β, γ coincidence by counting strongly active sources. The correction factor F due to the disintegration process for the gold is determined experimentally. Author (NSA)

N67-37953# Lyon Univ. (France). Institut de Physique Nucleaire.
STUDY OF A PULSATION DEVICE FOR A PROTON BEAM EMITTED FROM A VAN DE GRAAFF ACCELERATOR. APPLICATION TO THE MEASUREMENT OF THE LIFETIMES OF NUCLEAR EXCITED STATES [ETUDE D'UN DISPOSITIF DE PULSATION D'UN FAISCEAU DE PROTONS ISSU D'UN ACCELERATEUR VAN DE GRAAFF. APPLICATION A LA MESURE DE VIES D'ETATS NUCLEAIRES EXCITES]
Jean Claude Poizat (Ph.D. Thesis) 7 Nov. 1966 86 p refs In FRENCH
(LYCEN-6648)

After an enumeration of the various pulsation techniques -- for a particle beam, the principle and the development of a pulsation system based on a method by diaphragm sweeping was described. Emphasis was given to the study of focusing as it applied to obtaining short proton pulses. For the pulsation device constructed resolution time of less than two nsec was obtained. The lifetimes of the 110-keV level of ^{19}F and ot the 580-keV level of ^{25}Mg were measured as 0.84±0.04 and 4.97±0.15 nsec, respectively. Author (NSA)

N67-37956# Commisariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.

STUDY AND REALIZATION OF AN ELECTRON LINEAR ACCELERATOR: DYNAMICS OF ACCELERATED ELECTRONS [ETUDE ET REALISATION D'UN ACCELERATEUR LINEAIRE D'ELECTRONS. DYNAMIQUE DES ELECTRONS ACCELERES]

Jean Bernard (Ph.D. Thesis—Paris Univ., Orsay, France, 21 Dec. 1966) Apr. 1967 192 p refs In FRENCH

(CEA-R-3112)

The theoretical characteristics of the electron linear accelerator are: 30 MeV for the energy W_S and 250 mA for the peak current I_c. The main utilization is the intense production of fast neutrons by the reactions (γ,n) and (γ,f) induced in a target of natural uranium by the accelerated electrons. The study and the realization of the accelerator are discussed and a new equation of dispersion is established analytically when the guide is loaded with round-edged irises. The relation is compared with the equation established by Chu and Hansen, Walkinshaw, Kvasil in the case of a guide loaded with flat-edged irises. The experimental and theoretical curves of dispersion are compared. The accuracy of every relation of dispersion is estimated. Author (NSA)

N67-37958# Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies.

KINEMATICAL CONSTRAINTS ON REGGE POLE RESIDUES

B. Diu and M. Le Bellac Apr. 1967 22 p refs

(LPTHE-TH-198; NP-16821)

The problem of kinematical singularities and zeroes of Regge pole residues for processes with external spins is re-examined. The analyticity of the classical Mandelstam invariants introduce additional constraints into the Reggeization procedure proposed by L. L. Wang. The way these constraints work is described on simple examples, and the role of daughter trajectories is discussed; in particular, the latter are found to satisfy the factorization theorem. These considerations are then applied to vector meson production and charged pion photoproduction. In particular, the sharp forward peak observed in this last process, as in neutron–proton charge exchange, is seen to raise a serious problem within the Regge pole model. Author (NSA)

N67-37965# Yale Univ., New Haven, Conn. Sloane Physics Lab.

COMPARISON OF SEMICLASSICAL AND QUANTUM SCHEMATIC NUCLEON-TRANSFER MODELS

G. Breit, J. F. Masso, J. A. Polak, and D. A. Torchia 16 Jun. 1967 3 p refs Presented at the Intern. Conf. on Nucl. Struct., Tokyo, 7–13 Sep. 1967

(Contract AT(30-1)-1807)

(YALE-1807-45; CONF-670910-1) CFSTI: HC$3.00/MF$0.65

The semiclassical and quantum-theoretical treatments of the interaction of two particles D (for donor) and A (for acceptor) with masses m_D and m_A with each other through a potential V_{DA} and with a particle n of mass m_n through δ-function potentials are compared. Poor agreement occurs at unrealistically small distances of closest approach. NSA

N67-37966# Purdue Univ., Lafayette, Ind. Chemistry Dept.

DEEXCITATION PROCESSES IN HIGH-ENERGY NUCLEAR REACTIONS Progress Report, Feb. 1966–Apr. 1967

Norbert T. Porile May 1967 31 p refs

(Contract AT(11-1)-1505)

(COO-1505-17) CFSTI: HC$3.00/MF$0.65

Progress is reported on the following research: formation of ^{24}Na in the interaction of 11.5-GeV protons with Pb and U isotopes; cross sections and recoil properties of Ag and Pd nuclides produced in the fission of ^{239}U by 0.45- and 11.5-GeV protons; recoil study of reactions of Ag and In with 200- and 400-MeV protons; and angular distributions of products from $^{65}Cu(^3He,xn)$ reactions. NSA

N67-37971# California Univ., Riverside.

[HIGH-ENERGY PHYSICS] Annual Report

Walter H. Barkas May 1967 36 p refs

(Contract AT(11-1)-34)

(UCR-P107-46) CFSTI: HC$3.00/MF$0.65

Work that was carried out in several areas of high energy physics is described. Visual techniques are used. For the study of the three-pion decay of the K^+ meson, bubble chamber and emulsion methods are used to complement each other, particularly for the τ′ mode. Several separate bubble chamber experiments in π^+p, $\bar{p}p$ and K^-p interactions are also described, and the large effort devoted to computer reprogramming for the data analysis indicated. Two emulsion research projects are also described which have for their purpose the study of electromagnetic processes induced by 16-BeV electrons and the study of hypernuclei by I^- mesons. For the latter work high speed computer methods have been successfully applied to the analysis of the product hypernuclei. These programs of work have not been under way long enough for the main results yet to be available, but some preliminary data were published and several reports on data analysis and related subjects were prepared. Author (NSA)

N67-37974# Tokyo Univ. (Japan). Inst. for Nuclear Study.

PHENOMENOLOGICAL DISCUSSIONS ON ENERGY LEVELS, GAMMA TRANSITIONS, AND BETA TRANSITIONS OF MEDIUM-HEAVY NUCLEI

Hiroyasu Ejiri 6 May 1967 39 p refs

(INSJ-104)

Phenomenological discussions are made on the uniform property of the ground-state band levels in so-called spherical, transition, and deformed nuclei. The ground-state band structure throughout all even-even nuclei consists of levels with spin sequency 0^+, 2^+, 4^+, 6^+, .. and has generally some uniform properties of energy spectra, gamma transitions, and beta transitions. The excitation energy of the ground-state band level with spin I^+ is expressed by a simple form $E(I) = kI(I+1) + aI$. In this expression the coefficient k keeps approximately constant in nuclei with the same atomic number and depends slightly on the mass number, while the parameter a is characteristic of each nucleus. The reduced E2 transition probability between the ground-state band levels decreases gradually with the increase of the energy deviation term from the pure rotational motion. Using a unit of the B(E2) of pure rotational motion with energy spectrum $kI(I+1)$, one gets the relations $\sqrt{B(E2)} = u+ve^{-wa}$ with the one parameter a. Beta transitions from odd-odd nuclei to the ground-state band levels are hindered much more as the spins of the parent nuclei become larger. This fact just corresponds to the K selection rule. The ground-state band levels have uniform property as $K + 0$ in the beta transition. The existence of the uniform properties of the ground-state band levels shows that the properties expected for well-defined deformed nucleus persist more or less in all even-even nuclei. Author (NSA)

N67-37999# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
CORRELATED PROTON PAIRS IN A HIGH ENERGY NUCLEAR REACTION [EMISJA SKORELOWANYCH PAR PROTONOW W REAKCJACH JADROWYCH WYSOKIEJ ENERGII]
Teodor Siemiarczuk and Przemyslaw Zielinski 1967 7 p refs Transl. into ENGLISH from the 2d Intern. Conf. on High Energy Phys. and Nucl. Struct., Rehovoth, Israel
(INR-787/VI/PH; Conf-670207-5)

The emission of correlated proton pairs in 780 interactions of 9 GeV negative pions with xenon nuclei was observed. Author (NSA)

N67-38000# Brookhaven National Lab., Upton, N. Y.
ANALOG SIMULATION OF CESIUM PRODUCTION
Michael A. Rothbart and Leonard Galanter Jun. 1967 27 p refs Presented at the 13th Ann. Meeting of the Am. Nucl. Soc., San Diego, Calif. Prepared for AEC
(BNL-11474; CONF-670602-13) CFSTI: HC $3.00/MF $0.65

An analog simulation of the production of Cs isotopes, particularly ^{134}Cs, in the thermal neutron fission of ^{235}U is outlined. The analog computer is briefly described, and the differential equations used are given. NSA

N67-38014# Kiel Univ. (West Germany).
INVESTIGATION OF THE SCATTERING OF FAST NEUTRONS BY THE TIME-OF-FLIGHT METHOD BY MEANS OF A VAN de GRAAFF ACCELERATOR [UNTERSUCHUNG DER STREUUNG SCHNELLER NEUTRONEN NACH DER LAUFZEITMETHODE MIT HILFE EINES VAN DE GRAAFF-GENERATORS]
A. Moll, P. Johnsen, and M. Wollesen Jan. 1967 22 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-04)

The status of a fast neutron scattering experiment, in which a Van de Graaff accelerator with a pulse length of about 0.6 nsec and a pulse frequency of 2 MH_2 is used, is summarized. The flight path is 1.5 m in length, and pulsing is performed using a deflection condenser and a slit diaphragm. NSA

N67-38021# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy.
ON THE ACCURACY OF THE γ-QUANTA ENERGY DETERMINATION IN THE XE BUBBLE CHAMBER [O TOCHNOSTI OPREDELENIYA ENERGII γ-KVANTOV V KSENONOVOI PUZYR'KOVOI KAMERE]
I. A. Ivanovskaya, T. Kanarek, L. S. Okhrimenko, B. Slovinskii, Z. S. Strugal'skii et al 1967 16 p refs In RUSSIAN
(JINR-P1-3317)

The accuracy of the γ-quanta energy determination in the Xe bubble chamber is analyzed. For the γ-energy interval 40–2400 MeV it equals 12–35% according to the measurement condition. Author (NSA)

N67-38024# Kiel Univ. (West Germany).
ENERGY DETERMINATION OF ELECTROMAGNETIC CASCADES IN EMULSIONS BY THE ANGULAR DISTRIBUTIONS [ENERGIEBESTIMMUNG AN ELEKTRONEN-PHOTONENKASKADEN IN EMULSIONEN AUS DER WINKELVERTEILUNG]
W. Enge Apr. 1967 27 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-28)

Three electromagnetic cascades of energies 820, 160, and 85 GeV were measured in emulsions. Their integral angular distributions are shown to be functions of E_0-ϑ(GeV-rad) in the core of the cascade, analog to the well known fact that the integral radial distributions depend on E_0-R(GeV-rl) in the core of the cascade. Author (NSA)

N67-38028# California Univ., Livermore. Lawrence Radiation Lab.
IDENTIFICATION AND DETERMINATION OF GAMMA EMITTERS BY COMPUTER ANALYSIS OF Ge(Li) SPECTRA
R. Gunnink, H. B. Levy, and J. B. Niday 16 May 1967 23 p Presented at the Am. Chem. Soc. Symp. on Nucl. Methods of Chem. Analysis, Miami Beach, 10–14 Apr. 1967
(Contract W-7405-ENG-48)
(UCID-15140; CONF-670401-10) CFSTI: HC $3.00/MF $0.65

An application of the Ge(Li) gamma detector is its usefulness as a nondestructive analytical tool. However, the data from such systems are typically contained in 1000 to 4000 channels of a pulse-height analyzer and the gamma spectra are frequently complex. To reduce the effort of spectral interpretation to a minimum, a computer code was developed that will make an identification and quantitative determination of the isotopic components producing the complex Ge(Li) gamma spectrum. In addition to the general approach and operating considerations used in a quantitative analysis of this type, features of the computer code are discussed and typical results shown. The characteristics of the computer code are location of peaks in a spectrum, determination of the area of peaks, treatment of interferences of adjacent peaks, determination of precise peak energies, calculation of peak intensities, identification of the isotopes responsible for the peaks by using a library tape containing the necessary decay scheme information, and final calculation and tabulation of results. Author (NSA)

N67-38035*# Ohio State Univ., Columbus. ElectroScience Lab.
EXCITATION CROSS SECTIONS FOR SOME OF THE STATES OF $2p^4$-3p CONFIGURATION OF NEON AND $4p^4$-5p CONFIGURATION OF KRYPTON
S. H. Koozekanani 22 Sep. 1967 9 p refs
(Grant NsG-74-60)
(NASA-CR-88877; Rept.-1093-37) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Excitation cross sections for some of the $2p^4$–3p upper laser states of neon and $4p^4$–5p states of krypton has been calculated by assuming a fast electron strips away one of the bound valence electrons of the neutral atom in a very short time compared to the relaxation of the ion. Exact wave functions for the upper laser states of neon II and krypton II in terms of pure LS wave functions are found. Author

N67-38044 Tokyo Univ. of Education (Japan). Dept. of Physics.
A MODEL OF ELEMENTARY PARTICLES BASED ON INFINITE COMPONENT FIELDS
Syurei Iwao [1966] 5 p refs
(TUEP-67-15)

Creation, annihilation, diagonal, angular momentum, mechanical spin, and Casimir operators are defined. These are used in a mathematical model of elementary particles based on infinite component fields. The baryon state is used as an example. L.S.

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N67-36680# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
ANALYTICAL AND EXPERIMENTAL STUDIES OF MICROWAVE INTERACTION WITH A HYPERSONIC AIR PLASMA
Donald W. Boyer and Dean R. Bitikofer Feb. 1967 120 p refs
(Contract AF 19(628)-4968)
(AFCRL-67-0201; CAL-AA-2053-Y-1; SR-1; AD-656358)

Analytical and experimental studies are described of phenomena associated with the interaction of microwave radiation with the aerodynamically generated plasma surrounding a hemisphere-cylinder model in the CAL High Energy Shock Tunnel. The program consisted of three parts, namely, (1) measurements of the changes in antenna radiation patterns at C-band (4.25 GHz), (2) an investigation of antenna breakdown, and nonlinear signal transmission effects, at S-band (2.7 GHz), and (3) measurements of the coupling between two antennas at S-band. Nonequilibrium flow field calculations are discussed which describe the plasma properties in the vicinity of the antennas on the model. Analytical calculations have also included the computation of the complex transmission and reflection coefficients for microwave propagation through the inhomogeneous afterbody shock layer plasma. A Phase I series of experiments measured the effect of the hypervelocity plasma on the radiation pattern of a C-band transmitting antenna located on the model cylindrical afterbody. A Phase II experimental program investigated nonlinear interaction effects due to propagation of variable high power S-band pulse radiation through the afterbody shock layer plasma. Author (TAB)

N67-36681# Case Inst. of Tech., Cleveland, Ohio.
WAVE INTERACTION IN NONRELATIVISTIC ELECTRON BEAM-PLASMA SYSTEMS
Gerald A. Otteni Jul. 1967 152 p refs
(Contract AF 19(628)1699)
(AFCRL-67-0375; SR-17; AD-656346)

A theoretical model based on the linearization of the fluid equations and Maxwell's equations for wave interaction in a uniform plasma which is interpenetrated by a nonrelativistic electron beam is developed. The effects of electron-neutral and electron-ion collisions and temperatures of both the beam and plasma electrons are included and no quasi-static approximation is made for the electromagnetic field. An external D.C. magnetic field is assumed to act so that a general formulation is developed which is valid in the limit of small D.C. magnetic fields and in the limit as the field becomes very large. Graphs of the computer solutions are given for the propagation constants in a beam-plasma system for the cases of an unbounded system and for the TM wave solutions that may exist in an axisymmetric cylindrical system in which the finite beam interpenetrates an unbounded plasma. Author (TAB)

N67-36700# Ohio State Univ. Research Foundation, Columbus.
AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF ELECTRICALLY INDUCED CONTROLLED FREQUENCY PERTURBATIONS ON BOUNDARY LAYER TRANSITION
Jeffrey J. Ketcham and Henry R. Velkoff Jun. 1967 105 p refs
(Contract DA-31-124-ARO(D)-246)
(AROD-4942.4-E; TR-5; AD-655526)

An experimental investigation was conducted to determine the effects of corona discharge on boundary-layer transition. A flat plate was mounted in a low-turbulence wind tunnel. The location of transition was determined using a near-surface impact pressure probe. Boundary-layer excitation was accomplished by suspending a series of corona wires parallel to the plate outside the boundary layer. It was found that, under certain conditions, the transition point could be moved downstream upon application of a steady potential to the wires. Superposition of a pulsating potential did not influence the results over a wide range of pulsation frequency. Author (TAB)

N67-36722# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.
VARIABLE CONDUCTIVITY FULLY DEVELOPED MHD CHANNEL FLOW
Paul C. Kieffer Mar. 1967 75 p refs
(ARL-67-0046; AD-655369)

Fully developed MHD channel flow was studied for several conductivity profiles to determine the effect of non-uniform electrical conductivity on the flow variables. The velocity profiles, volume rate of flow, and shear at the wall were investigated. If the conductivity only varies near the wall, the flow is moderately affected. If the conductivity in the central portion of the channel varies, significant changes (as much as 300% error based on uniform conductivity results) can occur. Variable conductivity has its greatest effect when the conductivity increases from the centerline to the walls. Inflection points can occur in the velocity profiles when the conductivity decreases from the centerline to the walls. Author (TAB)

N67-36803# Brandeis Univ., Waltham, Mass. Dept. of Physics.
GENERALIZED MAGNETO-IONIC THEORY FOR STRONG ELECTRIC FIELDS Interim Scientific Report
Pradip M. Bakshi Jun. 1967 24 p refs
(Contract AF 19(628)-4019)
(AFCRL-67-0397; SR-3; AD-655788)

The generalized magneto-ionic theory (Sen and Wyller, 1960) with velocity dependent electron-neutral collisions is considered here for strong electric fields which significantly alter the isotropic part of the electron distribution function. Explicit expressions are developed for the distribution function and the non-linear conductivity for the special case of practical interest where the collision frequency is proportional to the energy. Some of the implications and possible applications for ionospheric problems are outlined in the last section. Author (TAB)

N67-36807# Aerospace Corp., El Segundo, Calif. Aerodynamics and Propulsion Research Lab.
SCATTERING OF ELECTROMAGNETIC WAVES BY VORTICITY FLUCTUATIONS
F. S. Roehrs Apr. 1967 44 p refs
(Contract AF 04(695)-1001)
(TR-1001(2240-20)-9; SSD-TR-67-61; AD-655783)

A weak-probe theory was developed to describe the incoherent scatter of microwaves by the vorticity fluctuations in a shear generated turbulent flow. The theory is based on a turbulent analog to the Onsager regression hypothesis. The power spectrum of the scattered wave is determined by the regression of the turbulent fluctuations and their convective motions. The regression function is developed from the turbulent energy transfer equation, which also determines the mean square amplitude of the fluctuations. Author (TAB)

N67-36863# Montreal Univ. (Quebec). Dept. of Physics.
PLASMA PHYSICS LABORATORY [LABORATOIRE DE PHYSIQUE DES PLASMAS] Activity Report No. 3, Oct. 1965–Oct. 1966
Oct. 1966 61 p refs In FRENCH; ENGLISH summary

During this reporting period, emphasis was placed on: Townsend ionization and attachment coefficients in gas mixtures; glow discharges and plasma probes; interaction of electromagnetic waves with plasmas; and radiofrequency velocity selector for electrons. Experimental measurements on ionization and attachment coefficients in admixtures of chlorine in argon (0.1% to 10% chlorine) were completed. The apparatus for detailed study of the behavior of the attachment coefficients for very low concentrations of chlorine in argon was improved. An experiment on double

probe measurements in a coaxial discharge was completed. A large part of the effort on glow discharges and probes was directed toward the production of clean and stable plasmas. An experimental comparison of brush cathode discharges and multihole cathode discharges was initiated also during this period. R.U.

N67-36936# New York Univ., N. Y. Dept. of Physics.
TEST OF THE DIRECT INTERACTION MODEL FOR ATOMIC REACTIONS; CORRELATION OF THE OUTGOING ELECTRONS IN ELECTRONIC IONIZATION
A. E. Glassgold [1967] 10 p refs Presented at the 5th Intern. Conf. on the Phys. of Electron. and Atomic Collisions, Leningrad, 17–23 Jun. 1967
(Contract Nonr-285(58))
(N67-2; AD-656052)

In the classical theories, as well as in the Born approximation, it is assumed that an atomic reaction initiated by an electron proceeds by way of a single collision with one of the target electrons. This is named the Direct Interaction Model (DIM), adopting the terminology from nuclear physics. The purpose of the paper is to propose an experimental test of this model for atomic reactions. TAB

N67-36956# Institut za Nuclearne Nauke (Boris Kidric), Belgrade (Yugoslavia).
SURFACE WAVE MEASUREMENTS ON THE POSITIVE COLUMN OF A MERCURY VAPOR ARC
Bozidar A. Anicin *In its* Bull. of the Boris Kidric Inst. of Nucl Sci., Vol. 17, No. 2 1966 p 89–96 refs (See N67-36954 22-34)

Standing surface waves in the axially symmetric TM mode were excited on the positive column of a sustained mercury vapor arc and the dispersion relation verified experimentally. The measurements were carried out at oscillator frequencies ranging from 50 to 200 Mc/s and electron densities from 4.10^8 to 9.10^8 el/cm^3. Electron densities obtained in this way agree with Langmuir probe data and microwave cavity measurements on similar tubes. Author

N67-36967# Toronto Univ. (Ontario). Lash Miller Chemical Labs.
DISTRIBUTION OF ENERGY IN ELECTRICAL DISCHARGES Final Report, Jun. 1966–May 1967
Jacques M. Deckers May 1967 23 p refs
(Grant AF-AFOSR-375-66)
(AFOSR-67-1793; AD-656434)

Preliminary results are reported of the emission intensity of CO bands in the positive column of a DC glow discharge through fast flowing ethane oxygen mixtures. A description is given of an apparatus for measuring atomic oxygen concentration in the positive column of a discharge. A description is given of an apparatus for measuring electron energy distribution in the positive column of a slow discharge. A survey is presented of the emission of Nitrogen triplet bands in the positive column of a DC glow discharge. It is shown that population of B and C state do not increase proportionately. Author (TAB)

N67-36971# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
KINETIC EQUATIONS FOR PLASMAS
Toyoki Koga Apr. 1967 82 p refs
(Contract Nonr-839(38); ARPA Order 529; Proj. Defender)
(PIBAL-1007; AD-655615)

Because of the time scale assumption necessary for its derivation, the Bogoliubov-Born-Green-Kirkwood-Yvon (BBGKY) hierarchy of equations is not applicable to systems consisting of charged particles, except for special subsystems. A new class of equations governing the evolutions of charged particles is derived from the Liouville equation and is coarsed-grained with respect to time and similar particles. In the zeroth approximation, there are two basic types of inter-particle interactions: One is of the Vlasov type and the other of the Boltzmann type characterizing interactions among nearest neighboring particles. In higher order approximations, mutual perturbations among those basic interactions result in secondary effects; for example, two nearest-neighboring particles exert a force of microscopic order to another particle. Depending on the ratio between the number of electrons and the number of ions in a real system, the simulating model varies. The main purpose of the paper is to present schemes of rational treatment, rather than to provide numerical results in detail for a particular system. Author (TAB)

N67-36976# Sperry Rand Research Center, Sudbury, Mass.
PLASMA TRANSPORT AND STABILITY IN A "MINIMUM B" MAGNETIC FIELD Final Report
W. D. Mc Bee, J. A. Decker, P. J. Freyheit, and S. Gruber Apr. 1967 115 p refs
(Contract AF 49(638)-1541)
(SRRC-CR-67-15; AFOSR-67-1785; AD-654341)

The report covers the second year's effort under a program of research into fusion-plasma containment, transport and stability in which a relatively small, versatile, accessible and inexpensive thermally-ionized cesium plasma is used as an experimental simulant for a hot fusion plasma. The characteristics of the simulant plasma and the basis of simulation have been presented earlier; this report will cover the detailed investigation of 'anomalous' plasma transport in the simulant plasma of the topsy Q-device-with special attention to a possible correlation of plasma transport and low-frequency plasma oscillations and to ionizer-temperature-gradient effects-in uniform axial and 'minimum-B magnetic field geometries, as well as some preliminary results of a continuing investigation into ion-velocity-anisotropy driven 'microinstabilities'. Author (TAB)

N67-36988# Massachusetts Inst. of Tech., Cambridge. Aerophysics Lab.
NOZZLE FLOW OF A CHEMICALLY REACTING AND RADIATING IONIZED GAS
Robert C. Sepucha Jun. 1967 83 p refs
(Contract AF 49(638)-1621)
(MIT-DSR-76052; AFOSR-67-1397; TR-141; AD-655836)

A theoretical investigation is presented of the flow of a radiating ionized gas through a supersonic expansion nozzle. The gas model employed is that of singly ionizable argon possessing a nonequilibrium concentration level and a nonequilibrium energy distribution. A consistent mathematical description is devised which includes the effects of a multistep collisional ionization process as well as those of bound-bound and bound-free radiative transitions. Emphasis is placed on the contributions of the nonequilibrium radiation field in the general case as well as the optically thick and thin limits. An explicit form of the critical speed of a two temperature gas is also presented. Author (TAB)

N67-36993# California Univ., Livermore. Lawrence Radiation Lab.
A RELATIVISTIC CALCULATION OF THE BREMSSTRAHLUNG SPECTRUM OF A MAXWELL–BOLTZMANN PLASMA
Chris Quigg 6 Apr. 1967 24 p refs
(Contract W-7405-ENG-48)
(UCRL-50227) CFSTI: HC $3.00/MF $0.65

A numerical description of the spectrum of electron–ion bremsstrahlung from a Maxwell–Boltzmann plasma is obtained, using relativistic expressions. Results are given for specific temperatures in the range from 7.5 to 300 keV. Author (NSA)

N67-37076# Aktiebolaget Atomenergi, Stockholm (Sweden).
POWER DISTURBANCES CLOSE TO HYDRODYNAMIC INSTABILITY IN NATURAL CIRCULATION TWO-PHASE FLOW
R. P. Mathisen and O. Eklind Jul. 1967 33 p refs
(AE-285)

The current experiments in SKALVAN examined whether or not slow oscillations could influence the hydrodynamic stability limit of the individual boiling channels. While operating the loop close to the threshold of hydrodynamic instability, the power was pulsed in the boiling channel. The pulse widths had a lower limit of 0.65 sec due to the contactor time constant. The square wave power oscillation amplitude was 12.2%, $0<T_o/T<0.5$ where T_o was the mass flow oscillation period. The corresponding mass flow oscillations remained damped for all disturbance periods. With minimum test section inlet restrictions the power level at instability was much lower than that at burnout conditions. At higher restrictions these phenomena occurred at approximately equivalent power levels. The experiments with minimum inlet restrictions were also performed beyond the instability threshold. In this case it was possible to exceed the nominal burnout point temporarily by 5 per cent or more for periods of the order of magnitude 1 second. Even now the boiling channel conditions were not so severely affected that the burnout detectors tripped, and the power disturbances caused low frequency modulated wave trains.
Author

N67-37095# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
AXISYMMETRIC MODES IN HYDROMAGNETIC WAVEGUIDE
Gerald B. Kliman (Ph.D. Thesis) 28 Feb. 1967 108 p refs
(Contract DA-36-039-AMC-03200(E); Grant NSF GK-524)
(TR-449; AD-656720)

The axisymmetric, transverse magnetic field modes of a hydromagnetic or Alfven waveguide are studied experimentally and theoretically. An experiment was performed to examine with precision measurements the steady-state half-wave resonances of a short section of hydromagnetic waveguide with a liquid metal (NaK) used as the fluid conductor. The response to a step of current was also examined. The theory of uniform hydromagnetic waveguides is reviewed and extended by reconsideration of the propagation constant and theories for the effects of transverse fields, viscosity, finite conductivity walls, and bulk motion. A theory predicting the effects of nonuniform density or magnetic field is developed and verified in the experiment. Author (TAB)

N67-37196 United Kingdom Atomic Energy Authority, Culham (England). Research Group.
CLOSED MAGNETIC CONFIGURATIONS FOR THE CONTAINMENT OF PLASMA
L. S. Solovev and V. D. Shafranov 1967 189 p refs
(CLM-TRANS-12) HMSO: 24s

A theoretical investigation was made of magnetic field configurations suitable for containing plasma, and in particular with toroidal configurations in which the magnetic field lines form a set of nested magnetic surfaces. The basic parameters of toroidal configurations determining both the stability of the magnetic surfaces and that of the plasma located in a toroidal trap, are outlined.
Author

N67-37316*# Pennsylvania State Univ., University Park. Dept. of Electrical Engineering.
HYDROMAGNETIC WAVES—THEORY AND APPLICATIONS
Scientific Report
R. P. Kanwal 1 Oct. 1967 42 p refs
(Grant NsG-134-61)
(NASA-CR-88702; SR-310) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The influence of magnetohydrodynamic waves on various physical phenomena such as magnetosphere, heating of the solar corona, controlled thermonuclear reaction, propagation of the whirl rings from the sun's core to its surface and the cosmic rays are investigated. A survey of general theory and results of MHD waves introduce the work.
Author

N67-37340* California Univ., Berkeley. Dept. of Physics.
NONLINEAR OSCILLATIONS IN A COLD PLASMA
R. C. Davidson and P. P. J. M. Schram Aug. 1967 36 p refs
(Grants NGR-05-003-220; NSF GP-4454; AF-AFOSR-130-66)
(NASA-CR-88714) CSCL 20I

In a Maxwell-fluid description large amplitude electrostatic and electromagnetic oscillations in a cold plasma are analyzed in situations where the spatial variations are one-dimensional and the ions form a fixed neutralizing background. In the electrostatic approximation a Lagrangian description following the electron motion is adopted, and exact solutions obtained in these variables in situations where multistream flow does not develop. The inversion to Eulerian coordinates is conducted for an initial sinusoidal perturbation in density. A model describing the dispersive modifications of (weak) thermal effects is analyzed showing the phase-mixing of (moderately) large amplitude initial disturbances. Electromagnetic oscillations are considered as developing from small initial values on the background of the large amplitude longitudinal oscillations already calculated. The resulting wave equation is analyzed for several limiting cases. In the electrostatic approximation a special class of periodic Bernstein–Greene–Kruskal waves without trapped particles is obtained. A simple class of special stationary solutions is finally obtained for the complete problem including all magnetic force terms.
Author

N67-37348# Royal Inst. of Tech., Stockholm (Sweden). Div. of Plasma Physics.
PLASMA CONFINEMENT IN RING-CURRENT CONFIGURATIONS
Bo Lehnert 18 Apr. 1967 43 p refs
(Rept.-67-05) CFSTI: HC $3.00/MF $0.65

The field from one or several ring-shaped coils can be used as a magnetic bottle for plasma confinement. In stationary operation as a fusion device, the coils have to be suspended. A possible method is provided by magnetically screened leads. In the confinement volume defined by field lines encircling one of several ring-shaped coils, a static plasma equilibrium should be possible even in the presence of the magnetic field from the leads. The particle losses introduced by leads are mainly nonadiabatic. They are due to deviations from the constancy of the (1) equivalent magnetic moment in some very small regions where the field is weak and longitudinal invariants which arise when a particle passes the lead region repeatedly and in finite steps. These effects produce a scattering which displaces a particle randomly across the magnetic field by about one Larmor radius for each complete lead passage. Under thermonuclear conditions the losses due to the leads become negligible compared to the thermonuclear power when the main field is purely poloidal. In a sheared field the same losses are larger, but it should still be possible to make them less than the thermonuclear power.
Author (ESRO)

N67-37455# United Aircraft Corp., East Hartford, Conn. Research Labs.
INVESTIGATION OF THE MECHANISMS ASSOCIATED WITH GAS BREAKDOWN UNDER INTENSE OPTICAL ILLUMINATION Semiannual Report, 1 Jan.–30 Jun. 1967
David C. Smith and Alan F. Haught Jun. 1967 35 p refs
(Contract Nonr-4696(00); ARPA Order 306)
(UACRL-F920272-10; AD-656084)

The work reported is part of a series of experimental and theoretical investigations of the mechanisms responsible for gas

breakdown with focused optical frequency laser radiation. The effects of the mode structure of the laser radiation source on the gas breakdown threshold were studied. Experiments were also performed using a Mach-Zehnder interferometer to observe the breakdown plasma density and to determine the persistence and growth rate of the associated blast wave. The development of a high-power CO2 laser with an output at 10.6-micron wavelength was continued. TAB

N67-37487* International Information, Inc., Philadelphia, Pa.
THE POSITIVE COLUMN IN A SKEWED MAGNETIC FIELD [POLOZHITEL'NYY STOLB V SKOSHENNOM MAGNITNOM POLE]
E. M. Drobyshevskiy Washington, NASA, Dec. 1966 15 p refs Transl. into ENGLISH from Zh. Tekhn. Fiz. (Leningrad), v. 36, no. 7, 1966 p 1175–1185
(Contract NASw-1499)
(NASA-TT-F-10673) CSCL 20I

Equations were obtained for the case when $\omega_e\tau_e >> 1$, $\omega\tau_i << 1$, which describe the weakly ionized plasma of the positive column in a gas discharge. The plasma is formed between two infinitely long dielectric planes, in the presence of a skewed magnetic field, having a component in the direction of the external electric field. The equations are solved for the case when the magnetic field is almost perpendicular to the external electric field. The effects of skewness of the magnetic field and the parameters of discharge are found to be quite significant, especially on the charge carrier distribution. If the force lines of the homogeneous skewed magnetic field are fractured, discharge may be either focused or defocused. Author

N67-37501# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
PLASMA PRODUCTION BY A HIGH-POWER Q-SWITCHED LASER Quarterly Progress Report, 1 Feb.–30 Apr. 1967
A. G. Engelhardt 30 Apr. 1967 6 p
(Contract AT(30-1)-3472)
(WERL-3472-6; QPR-1) CFSTI: HC $3.00/MF $0.65

Development status of the gigawatt laser and its supporting equipment is given. Also, equipment for photon scattering experiments and microwave experiments is discussed. NSA

N67-37527# Canadian Armament Research and Development Establishment, Valcartier (Quebec).
ELECTROSTATIC PROBE MEASUREMENTS IN THE TURBULENT WAKE OF HYPERSONIC SPHERES FIRED IN A BALLISTIC RANGE
D. Heckman, A. Cantin, and A. Kirkpatrick *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 2 May 1967 44 p refs (See N67-37521 22-12)
(ARPA Order 133)

Electrostatic probes were used in the CARDE ballistic ranges to investigate the plasma characteristics of the turbulent core of the hypersonic wake. Cross correlations of the collected current signals obtained with arrays of electron or ion probes yield information relating to the space correlation, convection velocity, and moving frame autocorrelation of the change density fluctuations in the wake cone. Also obtained are power spectra and autocorrelations from individual probe signals. Experimental data derived in the wake of 1.0 and 2.7 inch diameter nonablating spheres at velocities exceeding 15,000 feet per second in air and at pressure between 1 and 100 mmHg are presented. The results are discussed in the light of other experiments being conducted at CARDE. Author

N67-37528# Institut Franco-Allemand de Recherches, St. Louis (France).
STUDY OF ELECTRONIC WAKES IN THE TUNNEL OF A HYPERBALLISTIC RANGE [ETUDES DE SILLAGES ELECTRONIQUES AU TUNNEL DE TIR HYPERBALISTIQUE]
M. Laug *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 2 May 1967 21 p refs In FRENCH; ENGLISH summary (See N67-37521 22-12)

Projectiles, usually spheres, are fired at approximately 6,000 m/s in the ISL hyperballistic range. Their ionized wakes are analyzed by the resounding cavity method (250 MHz), the input impedance of which is recorded on an abacus. The frequency of collisions between electrons and neutral particles, and the total number of electrons inside the cavity are then derived. From these data, the electron density curves as a function of distance have been drawn, assuming that the radial distribution of electrons is uniform and assigning to the wake a theoretically assessed diameter. Tests are being conducted to measure the diameter, instead of computing it, by measuring simultaneously a third parameter which is the phase displacement of a hyperfrequency wave. A varying frequency hyperfrequency interferometer might allow the assumption of a uniform radial distribution to be discarded. The instrumentation is described. Author

N67-37529# General Motors Corp., Santa Barbara, Calif. Aerospace Operations Dept.
WAKE ELECTRON DENSITY MEASUREMENTS BEHIND HYPERSONIC SPHERES AND CONES
R. A. Hayami and R. I. Primich *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 2 May 1967 51 p refs (See N67-35721 22-12)
(Contract DA-01-021-AMC-11359(Z))

The experimental data are considered significant for a number of reasons. For spheres, the measured electron density level extends from the recompression zone immediately behind the sphere into the far wake and so includes all regions of the wake where different electron-removal mechanisms are believed to exist. Different pressure regimes, in which various measured fluid dynamical effects are shown to have a profound influence on electron density decay, are also covered. Scalability of near-wake has been demonstrated previously and an example which shows binary scaling extending to the far wake is presented. The wake electron density data behind cone models fired at velocities of 23,000 fps are believed to be unique. Data for firings of a 12.5° half-angle cone with 1/4 inch base diameter at different range pressures and ratios of N_2–O_2 concentration are presented. Author

N67-37530# France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
UTILIZATION OF SHORT ARC WIND TUNNELS FOR THE STUDY OF IONIZED WAKE [UTILISATION AND SOUFFLERIES A ARC BREF POUR L'ETUDE DES SILLAGES IONISES]
J. Dorey and D. Compard *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 2 May 1967 30 p refs In FRENCH; ENGLISH summary (See N67-37521 22-12)

Summary data are presented on experimental and theoretical studies dealing with the plasma sheath surrounding models in the short arc wind tunnels of ONERA. The study of the impact layer by means of electrostatic probes and reflectometric methods has made it possible to reach a satisfactory agreement (during a great part of the gust) between the experimental results and the calculated determinations for a chemical nonequilibrium flow (which justifies a posteriori the use of these tunnels for such studies). The theoretical determination of the characteristics of an ionized flow is still too uncertain to permit a comparison with experimentation. In the wake experimentation, the models used are of the hemisphere-cone type with body-base diameters of 65 and 186

mm. They are held by thin wires which break at gust start. The displacement of the model during the useful phase may be short and is, in all cases, recorded. The wake diagnostic will be performed by three series of probe combs (electrostatic triple-probe); thus the local plasma characteristics will be obtained radially and lengthwise. Author

N67-37533# Naval Ordnance Lab., White Oak, Md.
BALLISTICS RANGE MEASUREMENTS OF WAKE ELECTRON DENSITY AND SPECTRAL EMISSION
C. J. Infosino, R. R. Gastrock, and R. A. Leverance *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 2 May 1967 32 p ref
(See N67-37521 22-12)

Experiments in ballistic ranges have been made, to determine the electron density and the spectral emission from the wake of projectiles subjected to reentry flight conditions. Materials include stainless steel, copper, aluminium, titanium, nylon phenolic, teflon and many others. Wake electron density is determined as a function of distance behind the projectiles through the use of 5 and 25 kmc focused microwave interferometers. Since there is a 40-foot separation between interferometers, angle of attack effects for bodies of revolution can be isolated. The spectral emission in the visible and near infrared region is also determined as a function of the distance behind the projectile. Spectral resolution is achieved through the use of prism and grating dispersion elements as well as the use of filters. Nine spectrophotometers located along the range tube yield the radiation intensity from the model as a function of distance along the range. With certain simplifying assumptions these data can be converted to give the ablation rate history of the projectile. Author

N67-37564# Microwave Electronics Corp., Palo Alto, Calif.
STUDY OF MICROWAVE GENERATION UTILIZING DOUBLE-STREAM INSTABILITIES IN ANISOTROPIC MEDIA Final Report
L. D. Buchmiller and S. Kakihana Jun. 1967 134 p refs
(Contract DA-36-039-AMC-03424(E))
(ECOM-03424-F; AD-654788)

The report describes the theoretical and experimental investigation of the two-stream instability in bismuth, pyrolytic graphite, germanium, and silicon, as possible sources of radiation in the submillimeter to far infrared regions. The theory for the semimetals, Bi and PG, is concerned with the two-stream interaction of electrons and holes moving in opposite directions under the influence of an applied electric field. The theory for the anisotropic semiconductors, Ge and Si, considers the two-stream interaction of light and heavy electrons moving in the same direction. The band structure of these materials were incorporated into the plasma dispersion relations. The carrier velocity distributions were included by the use of the Boltzmann transport equation. The dispersion relations were numerically evaluated on a digital computer for the growth rate and the frequency of the instability for waves propagating in the principal crystalline directions. The results obtained by the present investigation clearly show that the details of band structure play a fundamental role in determining the character of two-stream instability in anisotropic solids. Author (TAB)

N67-37584*# Harvard Coll. Observatory, Cambridge, Mass.
FE I, CR I AND CR II GF VALUES FROM SHOCK TUBE MEASUREMENTS
Martin Huber and Frank L. Tobey, Jr. Feb. 1967 66 p refs
(Grant NsG-438)
(NASA-CR-88736; SR-16) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Measurements of f-values by the absorption technique from a shock-heated gas are described. The line emission from the hot gas has made it necessary to apply corrections to the observed equivalent widths. Considerable line widths which are due almost exclusively to Van der Waals broadening have been observed. A correction for the resulting line wing absorption has been incorporated into the data reductions. The results show disagreements with gf-values of Corliss et al. (arc measurements) on the absolute scale and with lines which have an upper excitation potential exceeding 48,000 cm^{-1} on the relative scale. The latter discrepancy is attributed to a partially erroneous normalization function used in the previous measurements on an open arc. Author

N67-37625* National Aeronautics and Space Administration, Washington, D. C.
TRANSITION OF A NON-INDEPENDENT DARK DISCHARGE [UBERGANG EINER UNSELBSTANDIGEN IN EINE SELBSTANDIGE DUNKELENTLADUNG]
A. V. Engel and M. Steenbeck Sep. 1967 7 p Transl. into ENGLISH from Elek. Gasentladungenihre Physik Tech. (Berlin), 1932 p 43–48
(NASA-TT-F-11261) CSCL 20I

Approximate equations for the transition of a non-independent dark discharge into an independent one are derived for linear and cylindrical electrode devices. Author

N67-37684*# Texas Univ., Austin. Plasma Dynamics Research Lab.
PROPAGATION AND DISPERSION OF HYDROMAGNETIC AND ION CYCLOTRON WAVES IN PLASMAS IMMERSED IN MAGNETIC FIELDS Semiannual Status Report, 15 Jan.–14 Jul. 1967
15 Jul. 1967 62 p refs
(Grant NsG-353)
(NASA-CR-88535; SASR-9) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Theoretical investigations concerned with efficiency of RF power transfer to a cylindrical plasma are presented. The relationships between the six magnetic and electric wave field components are derived for the quasistatic case. Through suitable approximations, relations between the various wave field components are developed so that each of the components may be expressed in terms of quantities measurable in the laboratory. A method is proposed for determining wave power flow from magnetic probe measurements. Experimental measurements of RF power coupling to the plasma are described. A measurement of phase shift is described, with initial results indicating very large $\lambda_{\parallel}$. Results from the wavelength measurement are compared to theoretical calculations of $\lambda_{\parallel}$ based on measured electron densities. Observations of complex fine structure in the wave magnetic signal are also reported. Evidence of non-resonant coupling of RF power to the plasma is discussed. The so-called "Mode X" which is thought to be responsible is described, along with suggestions for its elimination, involving improved Faraday shielding of the Stix coil. An investigation of waves which propagate at low magnetic fields ($B_0 \leq 1000$ G) is reported. The study of nonlinear frequency phenomena is continued and extended to low magnetic field waves. Author

N67-37704# Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik.
WORK REPORTS OF THE THEORETICAL AND EXPERIMENTAL GROUPS FOR 1966 [ARBEITSBERICHTE DER THEORETISCHEN UND EXPERIMENTALLEN GRUPPEN FUER DAS JAHR 1966]
K. Vogelbruch, comp. Jun. 1967 85 p refs In GERMAN
(JUL-494-PP) CFSTI: HC $3.00/MF $0.65

The work of the theoretical group comprises waves of finite amplitude in plasma with magnetic field; kinetic theory of plasma and electromagnetic field; two-dimensional stationary boundary layers between plasma and magnetic field; calculation of surface

current density on the surface of an ideally conductive nonaxially symmetrical coil form; adiabatic invariance and magnetic field calculations; numerical calculations in respect of the theta pinch and finally the IBM-1620 computer. The experimental work concerns investigations on production of high temperature plasma (e.g. 600 k Joule compression and cusp geometry experiments); studies of plasma diagnostics (e.g. preheating in theta pinch, refraction measurements on a theta pinch plasma, a 1 m spectrograph with variable grazing incidence, a 2 mm microwave interferometer) and plasma acceleration. Basic experiments include nonstationary plasma diffusion, ionization of hydrogen in electric fields; stationary ring discharge and interaction between plasma and neutral matter. ESRO

N67-37715# European Space Research Inst., Frascati (Italy).
REPORT ON A STUDY GROUP ON LASER-PRODUCED PLASMAS
T. S. Green Paris, ESRO, Apr. 1967 12 p refs
(ESRO-SN-69) CFSTI: HC $3.00/MF $0.65

A small study group was held at ESRIN to discuss the production of plasmas by lasers and their application to plasma physics and spectroscopy with reference to the work of ESRIN. Delegates attended from several European laboratories. Discussions were divided into: (1) theory of plasma production using solids; (2) experimental observations using solid targets; (3) measurement techniques; (4) laser techniques; (5) gas breakdown and plasmas; (6) spectroscopic observations; and (7) application to ESRIN problems. Author (ESRO)

N67-37737*# National Aeronautics and Space Administration, Washington, D. C.
SYMPOSIUM ON COMPUTER SIMULATION OF PLASMA AND MANY-BODY PROBLEMS
1967 465 p refs Symp. held in Williamsburg, Va., 19–21 Apr. 1967; Sponsored by NASA. Langley Research Center and Coll. of William and Mary
(NASA-SP-153) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Papers on plasma physics, vlasov theory, magnetohydrodynamics and plasma devices, astrophysics, and neutral gases are presented. For individual titles see N67-37738–N67-37761.

N67-37738*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
COMPUTER EXPERIMENTS ON THE MICROSCOPIC THEORY OF PLASMAS
Marc R. Flaix, Gary A. Massel, and Richard H. Weinstein *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-Body Probl. 1967 p 3–23 refs (See N67-37737 22-25)

Results of computer experiments concerning Maxwellian and non-Maxwellian plasmas are reviewed. The Fourier charge density functions for infinite plasmas at thermal equilibrium are described. The excitation of long wavelengths is found to differ from the prediction of the collisionless theory, and reasons for the disagreement are discussed. The problem of potential fluctuations across a pair of grids is reviewed as a possibility for plasma diagnostics, and good agreement was obtained for both the static and the time-dependent analyses. Metaequilibrium, test particle distribution, and relaxation effects are also discussed. It is considered that the experiments give qualitative and quantitative checks with both Vlasov theory and some aspects of the first-order theory. N.E.N.

N67-37739*# Princeton Univ., N. J. Plasma Physics Lab.
INVESTIGATIONS OF NONLINEAR BEHAVIOR IN ONE-DIMENSIONAL PLASMA MODEL
J. M. Dawson *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-Body Probl. 1967 p 25–30 (See N67-37737 22-25)
(Contract AT(30-1)-1238; Grant NSF GP-579)

Experimental results are summarized on Landau damping of the large-amplitude plasma oscillation, mode coupling between two strongly excited plasma oscillations, and the turbulence generated by the passage of a weak beam through a plasma. It was found in the Landau damping investigation that the damping was stronger than predicted by linear theory and increased rapidly with increasing amplitude of the wave. Experiment and theory of mode coupling through the mechanism of nonlinear Landau damping were determined to be in agreement as long as quasi-trapped particles are avoided. This was accomplished by truncating the tail of the Maxwellian velocity distribution and supressing the amplitudes of all wavelength modes except the two excited ones. Agreements and disagreements between quasi-linear theory and numerical experiments on the turbulence produced in a one-species, one-dimensional plasma by a bump in the tail of the Maxwellian distribution are discussed. N.E.N.

N67-37740*# Stanford Univ., Calif. Inst. for Plasma Research.
SHOT NOISE IN THE LAGRANGIAN ONE-DIMENSIONAL MODEL
Christopher Barnes and D. A. Dunn *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-Body Probl. 1967 p 31–38 refs (See N67-37737 22-25)
(Contract DA-28-043-AMC-00482(E))

Results are presented of computer experiments designed to test the effects of coarse graining in the one-dimensional planar Lagrangian computer simulation of a one dimensional electron diode. Author

N67-37741*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
NONLAMINAR EFFECTS IN PLASMA SLAB OSCILLATIONS
H. M. Schneider and A. Bers *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-body Probl. 1967 p 41–56 refs (See N67-37737 22-25)
(Grant NSF GK-1165)

The dynamics of electrons which follow an initial displacement of the electron cloud in a cold plasma slab with tapered boundaries are presented. The behavior is quite different from the case where the slab has sharp boundaries. For a tapered slab, the time of first crossing depends on the amplitude of the initial displacement and the overtaking occurs for particles in the tapered region. If the initial displacement is small, overtaking takes place where ω_p' is a maximum and the time at which it occurs is inversely proportional to the initial displacement. Author

N67-37742*# Stanford Univ., Calif. Inst. for Plasma Research.
PRELIMINARY MEASUREMENTS OF NOISE IN A TWO-DIMENSIONAL ROD MODEL OF A PLASMA
R. W. Hockney *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-body Probl. 1967 p 57–60 ref (See N67-37737 22-25)

A derivation of the formula for the mean square fluctuating field appropriate to a particular type of computer model is presented, and the results are compared with measured values. The model is described, and plasma and galactic applications are mentioned. Two expressions are derived, one by replacing the physical Debye length by an effective Debye length, and the other from the thermal fluctuation theory expression. The data of measured values of the RMS E-field fluctuations and the values from the two formulas are tabulated, and it is concluded that both noise estimates agree with each other and with measured values. N.E.N.

N67-37743*# Princeton Univ., N. J. Plasma Physics Lab.
ON THE NUMERICAL SOLUTION OF POISSON'S EQUATION
Craig G. Smith *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-body Probl. 1967 p 63–71 refs (See N67-37737 22-25)
(Contract AT(30-1)-1238; Grant NSF GP-579)

A method of two-dimensional integration of Poisson's equation in a finite circular domain is discussed. The charge density data is fitted globally to a function. Poisson's equation is analytically integrated, and subsequent differentiations and integrations are performed. It is pointed out that there are a number of variations possible for the form of the approximation, and an example is given. It is felt that the method is most appropriate for fluid or guiding-center simulations of plasma. N.E.N.

N67-37744*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NUMERICAL STUDIES OF THE STEADY-STATE PLASMA SHEATH PROBLEM
Lee W. Parker and Edward C. Sullivan (Mt. Auburn Res. Associates) *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-body Probl. 1967 p 75–83 refs (See N67-37737 22-25)

Studies on plasma sheath problems are reviewed, and the numerical aspects of infinite-boundary problems are investigated. Emphasis is placed on the grid method of solving the associated ordinary differential equation, in which the solution is determined simultaneously at a number of points. The inherent instability in obtaining a solution by numerical means in problems where the potential vanishes at infinity is discussed, and the study is restricted to one-dimensional problems. Theory and results from experiments on a plasma diode problem indicate that there is a limitation of 20 Debye lengths for the electrode spacings with the grid method. This is contrasted to a limitation of 100 Debye lengths obtained by using a marching integration method with controlled error propagation. Further refinements in the grid method are reported to be under investigation. N.E.N.

N67-37745*# California Univ., San Diego.
NONLINEAR STUDY OF VLASOV'S EQUATION FOR A SPECIAL CLASS OF DISTRIBUTION FUNCTIONS
K. V. Roberts and H. L. Berk *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-body Probl. 1967 p 91–136 refs Sponsored by AEC and United Kingdom Atomic Energy Authority (See N67-37737 22-25)

Calculations on the water bag model of a two stream instability were made by following the motion of the phase space boundaries. Although the distribution function is locally randomized, a large scale nonlinear wave is observed. This wave is due to the condensation of holes in phase space which formally act as negative mass particles in that like charges attract one another. The subsequent development of the system depends on the dynamical interaction of the holes with each other and the plasma background. This evolution should be studied statistically, and to begin with, computer calculations have been made for a two hole collision. Statistically, the most probable final state of the simple water bag model is a Fermi distribution and it is important to determine to what extent the actual dynamics allows the system to relax to this state. Author

N67-37746*# Michigan Univ., Ann Arbor. Electron Physics Lab.
NONLINEAR SOLUTIONS OF THE VLASOV EQUATION BY VELOCITY SPACE EXPANSION IN LAGUERRE POLYNOMIALS
R. J. Lomax *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-body Probl. 1967 p 137–144 refs (See N67-37737 22-25)
(Contracts DA-36-039-AMC-02269(E); AF 30(602)-3569)

The solution of the Vlasov equation is discussed for the case in which longitudinal waves are considered, but there is no static magnetic field. It is assumed that there is a diode-like region and that a finite nth order polynomial expansion in velocity space can be made. Plots of the electrode density as a function of time in an electron–ion diode are given, and modifications are indicated for the case in which the particles have a drift velocity superimposed in their velocity distribution. N.E.N.

N67-37747*# California Univ., San Diego.
MAGNETOHYDRODYNAMIC PLASMA CALCULATIONS
K. V. Roberts *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-body Probl. 1967 p 163–189 refs (See N67-37737 22-25)

Some of the problems which are encountered in simulating the behavior of plasma devices on the computer are briefly outlined. Most of them only become serious when two- or three-dimensional calculations are attempted, and one of the critical problems lies in the treatment of the advective term. A conservative Eulerian difference scheme construction is described. The MHD conservation laws can be given an integral, space-time representation, which is reflected in the mesh to be used, and in the definition of the variables to be stored in the machine. The advective term in each equation is handled by a fourth-order method. Author

N67-37748*# Los Alamos Scientific Lab., N. Mex.
COMPUTER SIMULATION OF THE THETA PINCH
Thomas A. Oliphant *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-Body Probl. 1967 p 191–196 (See N67-37737 22-25)

A basic numerical program for the computer simulation of the straight cylinder theta pinch was written and is in operation. A good qualitative result was obtained for the initial pinch compression and the early phase of end loss. A periodicity of 2L was introduced, and the region investigated is located in the range $-L \leq z \leq L$. The inertial motion of the plasma is dominated by the more massive ions. The motion of the ions is described by a Lagrangian transport theory. The macroscopic current carrying properties of the system are dominated by the less massive electrons. The electron component is assumed to follow the ion component in such a way as to maintain charge neutrality. The electromagnetic field penetration is assumed to take place in accordance with Spitzer's formula. This carries with it the assumption of electron equilibrium. Author

N67-37749*# Commissariat a l'Energie Atomique, Saclay (France). Service d'Ionique Generale.
NONLINEAR HIGH FREQUENCY-PLASMA INTERACTION IN A MAGNETIC MIRROR
E. Canobbio and R. Collet *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-body Probl. 1967 p 199–216 refs (See N67-37737 22-25)

A large amplitude electromagnetic field accelerates the electrons of a beam injected in a mirror region. The ion motion is produced by the self consistent axial space charge field. When the electron velocity exceeds a critical value, steady electrostatic shock waves appear. Analytical and numerical computations are presented. Author

N67-37750*# Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering.

COMPUTER SIMULATION OF THE BEAM-PLASMA INTERACTION

J. A. Davis and A. Bers *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-Body Probl. 1967 p 217–235 refs (See N67-37737 22-25)

(Grant NSF GK-1165)

The effects of longitudinal plasma density gradients on the steady-state nonlinear beam-plasma interaction are studied by computer modeling with a finite diameter beam in an infinite plasma. The gradients and finite beam diameter seem necessary to explain the relatively narrow collected beam velocity distribution observed experimentally. For a given plasma density profile and beam density, the interaction becomes less intense as the total plasma density increases. Author

N67-37751*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

NUMERICAL SOLUTION FOR 1.5-DIMENSIONAL, TIME-DEPENDENT MAGNETOHYDRODYNAMIC PROBLEMS

Klaus Hain *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-Body Probl. 1967 p 237–264 (See N67-37737 22-25)

In problems such as theta pinches with parallel fields (after the first phases of implosion or solar flares), the overall structure is governed by a strong magnetic field. The Alfen speed across the field lines is high, and the full magnetohydrodynamic equations apply parallel to the field lines. The behavior of shock waves parallel to the magnetic field is studied under two conditions: (1) a theta pinch, with a conducting wall assumed at a distance equal to the characteristic radius, a magnetic field compressed at one end, and a specified damping time, and (2) simulation of the behavior of solar flares, assumed to have the structure of arcs consisting of magnetic field lines, a constant initial magnetic field, and the time dependent behavior simulated by compressing the magnetic field. The computations for the theta pinch show that no strong shock waves are produced by compressing the field, unless the field becomes strong or if the distance to the wall becomes very small. For the solar flares, it shows that a strong and long lasting field is required to achieve an appreciable amount of charge in the geometry. Author

N67-37752*# General Electric Co., Schenectady, N. Y. Research and Development Center.

THETA-PINCH SHOCK IMPLOSION CALCULATIONS BY MODEL SIMULATION OF COLLISIONLESS ION VLASOV EQUATION

R. W. Kilb *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-Body Probl. 1967 p 269–293 refs (See N67-37737 22-25)

Computations describing the implosion phase of high voltage low density theta-pinches are carried out by using the collisionless Vlasov equation for the ions, and using the fluid equation for adiabatic electrons. The calculations are on a time scale long compared to the electron cyclotron time, but short compared to the ion cyclotron time. The equations are reduced to a set of equivalent cylindrical plasma sheets. The calculations show that the non-adiabatic ion heating in very low bias, negative bias, and positive bias theta pinches results from ion interaction with rapidly fluctuating electric and magnetic fields inside the plasma, and with the rapidly converging outside surface of the plasma. The effects show plasma mass rotation, with the outside protion counter-rotating with respect to the inner portion in order to conserve over-all zero angular momentum. This rotation appears to be related to finite Larmor effects. Comparisons are made with experimental results. Author

N67-37759*# Columbia Univ., New York. Dept. of Mechanical Engineering.

NUMERICAL EXPERIMENTS ON THE NONLINEAR KROOK MODEL OF THE BOLTZMANN EQUATION

C. K. Chu *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-body Probl. 1967 p 369–374 refs (See N67-37737 22-25)

(Contract AF 49(638)-1634)

The Krook model of the Boltzmann equation is briefly reviewed, and investigations in one-space-dimensional time-dependent problems in neutral gases, in which shock waves occur, are surveyed. The following problems are covered: (1) steady state structure of a shock wave obtained by replacing the steady Krook equation by an integral equation, and solving the integral equation by iterations; (2) shock wave structure obtained by evaluating the collision integral by Monte Carlo methods; (3) a discrete ordinate method applied to unsteady and steady problems, and (4) a direct numerical method for the Krook equation in one-dimensional unsteady problems. N.E.N.

N67-37760*# California Univ., Berkeley. Dept. of Electrical Engineering.

COMPUTER EXPERIMENTS WITH CHARGED PARTICLES, CHARGED FLUIDS AND PLASMAS: A CLASSIFICATION AND BIBLIOGRAPHY

Charles K. Bridsall *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-body Probl. 1967 p 375–406 refs Sponsored by NSF (See N67-37737 22-25)

The computer experiments are listed and classified to aid in solving many-body and nonlinear systems. Computer experiments are classified according to application, and superparticle models are listed. Charged electron and ion fluids are covered, and definitions and jargon are mentioned. An extensive bibliography by year of publication is presented on the motion of charged particles and fluids in self and applied electric and magnetic fields. N.E.N.

N67-37791# Joint Publications Research Service, Washington, D. C.

COLD PLASMA (PLASMOTRON PRINCIPLES AND USES)

I. Lunacharskaya and V. Shchipachev 12 Sep. 1967 16 p Transl. into ENGLISH from Nauka i Zhizn, (Moscow), no. 7, 1967 p 32–39

(JPRS-42566; TT-67-33194) CFSTI: HC $3.00/MF $0.65

A definitive discussion is presented on the properties and characteristics of plasma. Methods of performing a plasma chemical process are described in terms of the industrial installations, the laboratory apparatus, and the areas of application. Details are given on the plasmatrons which usually use an electric arc discharge as a plasma generator; an electric arc plasmatron and a reactor for producing acetylene from methane; an electric arc plasma chemical installation with expendable graphite electrodes for the pyrolysis of gasoline; a nonelectrode high frequency plasmatron for producing high purity material; and a superhigh frequency plasmatron for nonequilibrium plasma production. M.G.J.

N67-37798# Royal Inst. of Tech., Stockholm (Sweden). Div. of Electron Physics.

MATERIAL TRANSPORT AND TEMPERATURE DISTRIBUTION IN ARC BETWEEN MELTING ALUMINIUM ELECTRODES

Erik A. Smaers and Kresimir Acinger 25 Apr. 1967 5 p refs Presented at the 8th Intern. Conf. on Phenomena in Ionized Gases, Vienna, 27 Aug.–2 Sep. 1967

(Rept.-67-06) CFSTI: HC $3.00/MF $0.65

Of decisive importance for the properties of high-current arcs of the types used in welding techniques are the following

processes: (1) the gas and plasma transport in the arc caused by thermal convection and, often more important, by the hydromagnetic pumping effect (known as the plasma jet), (2) the metal transport in the state of droplets and vapor between the electrodes, (3) the energy transport between the different arc regions brought about by gas and plasma streaming, heat conduction, and radiation; (4) the distribution of heat generation within the arc, and (4) the complicated processes in the transition regions between the arc plasma and the metal electrodes, e.g., the appearance or absence of cathode and anode spots. Some observations of an arc of the type used in the so-called MIG (metal inert gas) welding is presented. Author (ESRO)

N67-37816# European Space Research Organization, Paris (France).
PLASMAS IN SPACE AND IN THE LABORATORY
Apr. 1967 548 p refs In FRENCH and ENGLISH Proc. of the Esrin Study Group held in Frascati (Italy), 9 May–3 Jun. 1966 (ESRO-SP-20) CFSTI: HC $3.00/MF $0.65

Conference papers are presented on the physics of plasmas found in space and those produced in the laboratory. For individual titles, see N67-37817 through N67-37835.

N67-37817# Massachusetts Inst. of Tech., Cambridge.
MEASUREMENTS IN SPACE
B. Rossi *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 1–17 (See N67-37816 22-25)

The determination of the plasma parameters requires a measurement of the energy spectrum and of the angular distribution of the positive ion flux. The paper briefly describes the types of instruments used for this measurement, and the methods of analysis of the experimental data. It then summarizes the main features of the observational results, which indicate the existence of three distinct regions in the space around the earth. Author (ESRO)

N67-37819# Massachusetts Inst. of Tech., Cambridge.
PLASMA MEASUREMENTS IN INTERPLANETARY SPACE
H. Bridge and E. Lyon *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 65–91 (See N67-37816 22-25)

The paper reviews the experimental evidence concerning the undisturbed plasmas, i.e., the observational results obtained far from the earth. Particular attention is given to a description of the M.I.T. experiment on IMP-1 and to a discussion of the results obtained. The discussion includes (a) the analysis of the data to obtain appropriate average values of the bulk velocity, number density, and flux density; (b) the determination of the direction of plasma flow in the interplanetary region; (c) the evidence concerning the electron component in the interplanetary region; and (d) the clear definition, apparent in the data, of the interaction region near the earth. Author (ESRO)

N67-37825# Max-Planck-Institut für Physik und Astrophysik, Munich (West Germany).
COLLISION-FREE MAGNETO-HYDRODYNAMIC SHOCK WAVES
R. Luest *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 349–357 refs (See N67-37816 22-25)

Theoretical models for collision-free shocks are reviewed with restriction to magneto-hydrodynamic approximations and only magnetic interactions are considered as an essential basis for the collision-free shock waves. Characteristic for the treatment of the problem is the assumption that the interactions between the particles of the plasma occur collectively rather than in binary events. Some solutions of the equations which are relevant for this problem are discussed. ESRO

N67-37826# United Kingdom Atomic Energy Authority, Culham (England).
PLASMA WAVES
P. C. Thonemann *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 361–371 ref (See N67-37816 22-25)

The dispersion of small amplitude waves is discussed, particularly the physical mechanisms which lead to the appearance of different types of waves as the frequency and the wave vector are changed. It is assumed that a steady magnetic field exists throughout a uniform collisionless plasma consisting of two particle components, electrons and protons. The pressures are assumed isotropic and the Debye distance small compared to the plasma dimensions. No electrical currents or electric fields exist. The discussion is limited to plane waves with a wave front oriented at about 45° to the direction of the steady magnetic field. ESRO

N67-37827# United Kingdom Atomic Energy Authority, Culham (England).
PLASMA SPECTROSCOPY
R. Wilson *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 373–392 refs (See N67-37816 22-25)

The subject of plasma spectroscopy is introduced, oriented in the direction of high temperature plasmas and limited to radiation emission. Some laboratory experiments are described which are related to U.V. and X-ray astronomy. The requirement for fundamental data in these fields is increasing rapidly and measurement of spectral line wavelengths and atomic cross sections is greatly to be encouraged. Spectroscopic investigations made together with the application of laser techniques, both to produce plasmas and to measure plasma parameters, offer a particularly fruitful approach in this field. ESRO

N67-37828# Kernforschungsanlage, Juelich (West Germany).
EXPERIMENTS ON HYDROMAGNETIC SHOCK WAVES IN COLLISION–FREE PLASMAS
E. Hintz *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 393–402 refs (See N67-37816 22-25)

Starting from the present status of theory, some of the shock wave types which presently can be produced in collision-free laboratory plasma are described. The physical processes which may determine their structure are discussed and it is investigated under which experimental conditions such shock waves can be realized. The interest is concentrated on shocks in strong magnetic fields with the direction of propagation perpendicular to the magnetic field. The experimental methods used for the generation of collision-free shocks in the various laboratories are reviewed and the diagnostic techniques which have been employed are examined. The existing experimental observations and results are summarized and it is discussed which definite conclusions can be drawn. Author (ESRO)

N67-37830# Royal Inst. of Tech., Stockholm (Sweden). Div. of Plasma Physics.
LABORATORY EXPERIMENTS WITH PLASMA FLOW PAST UNMAGNETIZED OBSTACLES
U. Fahleson *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 432–449 refs (See N67-37816 22-25)

Several types of plasma flow are encountered in space physics; e.g. the motion of space vehicles through the magnetosphere and through the solar wind, the behavior of satellite antennas and different types of probes in a moving plasma, the interaction between the solar wind and the moon, meteors and comets. Typical problems are to determine the floating potential of the body and the current density to different parts of it, the plasma density and velocity in the neighborhood of it, the induced electric and magnetic fields, the occurrence and properties of possible standing shock waves and the properties of electromagnetic wave propagation through the disturbed plasma. ESRO

N67-37831# Royal Inst. of Tech., Stockholm (Sweden).
SCALING CONSIDERATIONS FOR MAGNETOSPHERIC MODEL EXPERIMENTS
Lars P. Block *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 450–466 refs (See N67-37816 22-25)

The scaling problems for plasma gun-terrella experiments on the interaction between the solar wind and the magnetosphere are considered. Good scaling requires a magnetized, collisionless supersonic and super-Alfvenic plasma wind. The gyro-radii should be small compared to the size of the magnetosphere both in the plasma wind and at the magnetopause. The Debye length should be small. The mean free paths should be long to produce collision-free conditions. The magnetosphere must be much larger than the terrella. It is found that a simulation of the entire magnetosphere and the collisionless shock requires plasma temperatures in excess of 10^7°K and terrella fields of the order of 10^8 gauss. However, the transition region and the outer parts of the magnetosphere beyond about 3 earth radii may be simulated by a plasma gun and a terrella with a finite surface conductivity. The collisionless shock may be simulated by a theta-pinch and the inner part of the magnetosphere by a PIG-discharge with high mirror ratios. Author (ESRO)

N67-37832# Royal Inst. of Tech., Stockholm (Sweden). Div. of Plasma Physics.
MODEL EXPERIMENTS ON SOLAR WIND–MAGNETOSPHERE INTERACTION
L. Lindberg *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 467–479 refs (See N67-37816 22-25)

This report reviews the latest model experiments made utilizing modern plasma technology and their main parameters, and compares and discusses results of different flow models (e.g. formation of a magnetic cavity, evidence of a bow shock wave, trapping of plasma in the magnetic cavity, etc.). Finally the present state of a model experiment is described. ESRO

N67-37833# Royal Inst. of Tech., Stockholm (Sweden). Div. of Plasma Physics.
A PROPOSAL FOR LABORATORY INVESTIGATIONS OF THE EFFECTS OF CONTACT POTENTIALS ON ELECTRIC FIELD MEASUREMENTS IN THE IONOSPHERE BY DOUBLE PROBE SYSTEMS
Rolf Bostroem *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 480–486 refs (See N67-37816 22-25)

To facilitate the design of experiments for measurements of electric fields in the ionosphere and to interpret the results from them, certain phenomena should be investigated in the laboratory. One important problem is the effect of the contact potentials. A contact potential difference between the two probe surfaces and patches with different contact potentials on the probes will affect the measurements. The contact potential is very sensitive to the absorption of gases on the surface. The amount of absorption (and thus the contact potential difference between the probes and the patchiness) may change during the flight of the probe system. It is proposed that laboratory investigations are made of these effects. A review of the problem is given in this paper. ESRO

N67-37834# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Gas Ionizzati.
PLASMA DIAGNOSTICS BASED ON LASERS
U. Ascoli-Bartoli *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 487–496 refs (See N67-37816 22-25)

The aim of this note on plasma diagnostics based on the travelling of light through the plasma itself is to give some information about the possibilities offered by this kind of diagnostics. The elementary phenomenon on which they are based is the Thompson scattering of a photon, caused by a free charge, in terms of which, as is well known, all macroscopic propagation phenomena (refractivity, diffraction and diffusion) can be described. Author (ESRO)

N67-37835# Kernforschungsanlage, Juelich (West Germany).
ACCELERATION OF PLASMA BY ELECTROMAGNETIC FIELDS
H. Tuczek *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 531–557 refs (See N67-37816 22-25)

A survey is given of the results and problems of the following devices: arc jets, steady state acceleration with crossed electric and magnetic fields in Faraday and Hall accelerators, pulsed acceleration performed with electrodes in rail and coaxial guns, and without electrodes in ring discharges and traveling wave accelerators. The application of these devices as plasma sources for simulation experiments is considered. Author (ESRO)

N67-37887# Institut fur Plasmaphysik G.m.b.H., Garching (West Germany).
ON THE RELATIVISTIC NON-LINEAR INTERACTION OF COLD PLASMAS WITH ELECTROMAGNETIC WAVES [ZUR RELATIVISTISCHEN NICHTLINEAREN WECHSELWIRKUNG KALTER PLASMEN MIT ELEKTROMAGNETISCHEN WELLEN]
Werner Luenow Jul. 1967 77 p refs In GERMAN; ENGLISH summary
(IPP-6158) CFSTI: HC $3.00/MF $0.65

The behavior of a fully ionized plasma composed of one type of atom and subjected mainly to electromagnetic waves is treated analytically: Forces due to the stress pressure tensors of the ions and electrons, to gravitation, and to ion-electron interaction, as opposed to electromagnetic forces, are ignored. The mean thermal particle velocities have to be sufficiently small compared with the phase velocities of longitudinal plasma waves. The problem is described by relativistic field equations and equations of motion. The general fundamental equations lead to a special system of equations yielding wave solutions in which all partial waves have the same space-time constant phase velocity. This system of equations provides: (1) a strictly analytical periodic solution of the nonlinear initial equations describing a transverse, circularly polarized electromagnetic wave; (2) such a solution of the nonlinear initial equation obtained when the ion oscillation is neglected; and (3) an approximate steady state solution of the nonlinear initial equations for the simultaneous coupling of the plasma, transverse waves, and longitudinal waves. Author

N67-37950# California Univ., Livermore. Lawrence Radiation Lab.
FORMATIVE TIME OF CROSSED-FIELD BREAKDOWN
Wulf B. Kunkel and Arthur R. Sherwood Mar. 1967 5 p refs Presented at the 8th Intern. Conf. on Phenomena in Ionized Gases, Vienna, 27 Aug.–2 Sep. 1967
(Contract W-7405-ENG-48)
(UCRL-17448; CONF-670810-1) CFSTI: HC $3.00/MF $0.65

A study of the formative time of a gas breakdown in an electric field at right angles to a very strong uniform static magnetic field is described. The breakdown was accomplished essentially by primary electron avalanches, and the effect of secondary electrons released at the cathode was, in a first approximation, neglected. The resulting simplifications permitted theoretical predictions, based on extrapolated values of observed or computed ionization rates and drift speeds, for the breakdown time as a function of the fields and gas density. The fair agreement between observed and predicted formative times was taken as a partial confirmation of the theory. NSA

N67-37991# Ceskoslovenska Akademie Ved, Roz. Ustav Fyziky Plasmatu.
LOW-FREQUENCY INSTABILITY OF AN INHOMOGENEOUS WEAKLY IONIZED PLASMA IN CROSSED ELECTRIC AND INHOMOGENEOUS MAGNETIC FIELDS
V. Kopecky Mar. 1966 20 p refs
(IPPCZ-50)

The drift dissipative instability that arises in a weakly ionized inhomogeneous plasma in crossed electric and magnetic fields is discussed. The potential perturbations are studied in the WKB approximation. The critical magnetic field beyond the value of which the plasma is again stable against the perturbations is computed. The effect of the inhomogeneity of the magnetic field modeled by a gravitational field is analyzed and the effect of a magnetic field growing in the direction opposite to that of the plasma density, pointed out. Similar phenomena also arise in the current-convective instability under certain circumstances. Author (NSA)

N67-37992# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
ANALYSIS OF POPULATION OF EXICTED STATES OF IONS AND ITS APPLICATION TO ELECTRON TEMPERATURE AND DENSITY MEASUREMENTS [ANALIZA OBSADZENIA STANOW WZBUDZONYCH JONOW I JEJ ZASTOSOWANIE DO POMIAROW TEMPERATURY I GESTOBOI ELEKTROWOW]
Szymon Suckewer 1967 33 p refs
(INR-782/XVIII/PP)

Step-wise excitations of ions are discussed and densities N_e of electrons at which the solar corona model is applicable to plasma are estimated. For this case the population of 2^1D_2 and 3^3P_2 states of C_{111} ion was calculated. Expressions for the ion densities at selected excited states, at which corona relations are not applicable, were obtained taking into account collisional de-excitation transitions. Dependence of density of C_{III} ions in states 2^1D_2 and 3^3P_2 on N_e and kT_e was determined for this particular case. Author (NSA)

N67-38007# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.
STIMULATED EMISSION FROM THE UPPER HYBRID RESONANCE IN A MAGNETOPLASMA
R. M. Hill, D. E. Kaplan, and S. K. Ichiki 15 Jun. 1967 9 p refs
(Contracts Nonr-2541(00)); AF 19(628)-5932)
(TR-11; AD-655450)

The report describes the first observations of coherent emission from the upper hybrid resonance of a magnetoplasma, and the measurement of the frequency of this resonance as a function of electron density. The technique reported constitutes a new and useful means for the study of collective phenomena in magnetoplasmas and may also serve as an accurate means for the direct measurement of electron density in such plasmas. Author (TAB)

N67-38029*# Maryland Univ., College Park. Dept. of Physics and Astronomy.
WAVES IN A PLASMA IN A MAGNETIC FIELD
Howard Martin Stainer (Ph.D. Thesis) Jun. 1966 87 p refs
Submitted for publication
(Grants NsG-695; NsG-220-62)
(NASA-CR-77929) CSCL 20I

Slightly nonlinear wave propagations in a collisionless plasma permeated by a uniform background magnetic field B_o are discussed. Externally generated electromagnetic waves propagating along B_o in a plasma described by the first three moment equations obtained from the Vlasov equation are considered. Spurious solutions are eliminated by the introduction of amplitude dependent wavenumber and frequency shifts into the calculation. It is found that the sign and ratio of the magnitudes of these dimensionless shifts can be correctly predicted by assuming that the cyclotron dispersion relation is modified by the finite wave amplitude effects. Internally excited longitudinal electrostatic oscillations propagating at arbitrary angles with respect to B_o are also considered. It is found that suitable anisotropic distributions of energetic or superthermal electrons coexisting with a thermal background can not only drive the fluctuation spectrum of the longitudinal oscillations up to very high levels, but can also concentrate the propagation vectors both parallel and perpendicular to B_o. Specific superthermal electron distributions which produce the desired splitting are found to be those with a kinetic temperature perpendicular to B_o much larger than that parallel to B_o. Author

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N67-38696*# Farnham (Frank C.) Co., Philadelphia, Pa.
SOME PHYSICAL PROPERTIES OF ALLOYS OF THE ZrC–NbC AND TaC–HfC SYSTEMS [NEKOTORYYE FIZICHESKIYE SVOYSTVA SPLAVOV SISTEM ZrC–NbC I TaC–HfC]
I. G. Barantseva, V. N. Paderno, and Yu. B. Paderno Washington, NASA, Aug. 1967 5 p refs Transl. into ENGLISH from Poroshkovaya Met. (USSR), v. 7, no. 2, 1967 p 70–73
(Contract NASw-1497)
(NASA-TT-F-11181) CSCL 20L

The Hall effect and electrical resistance of ZrC–NbC and TaC–HfC alloys at room temperature were determined in sample sequences with proportions of components varying every 10 mol %. X-ray analysis shows a double-line spectral pattern indicating the presence of two-phase mixtures in these alloys. Author

N67-38697*# Farnham (Frank C.) Co., Philadelphia, Pa.
ON THE NATURE OF THE OPTICAL INHOMOGENEITY OF QUARTZ [K PRIRODE OPTICHESKOY NEODNORODNOSTI KVARTSA]
G. V. Kleshchev, I. V. Kabanovich, and L. N. Chernyy Washington, NASA, Aug. 1967 4 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 174, no. 3, 1967 p 585–587
(Contract NASw-1497)
(NASA-TT-F-11197) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The results of a study on the inhomogeneity of quartz crystals by X-ray diffraction topographic methods are discussed. The resulting data are then compared with optical data. The study was performed with natural and artificial quartz crystals using a specially fabricated Lang camera. Two types of inhomogeneities are described: striae and banding. The authors conclude that striation is caused by dislocations and that banding may be attributed to the fact that the chemical nature of the complexes which precipitate on the crystal changes in the course of crystal growth as a result of fluctuation of the technical conditions. Author

N67-38716# Air Force Cambridge Research Labs., Bedford, Mass. Microwave Physics Lab.
MICROWAVE RECTIFICATION USING QUARTZ
Andrew James Slobodnik, Jr. Apr. 1967 70 p refs *Its* Phys. Sci. Res. Paper No. 319
(AFCRL-67-0143; AD-655778)

The linear and nonlinear behavior of a thin piezoelectric quartz disk under microwave-frequency excitation is considered both theoretically and experimentally. A theory developed for X-cut quartz predicts the generation of a dc electric field and a corresponding dc voltage across the disk, owing to second-order coefficients in the piezoelectric constitutive relations. These second-order coefficients are assumed to be the dominant nonlinearities of the system. Temperature effects are neglected. Microwave acoustic resonances corresponding to high harmonics of the fundamental elastic standing wave were observed for X-cut and AC-cut quartz disks, in excellent agreement with the linear theory. Equivalent-circuit methods for description and measurement of these resonances are given. An equivalent circuit describing the nonlinear dc behavior of the disk derived for a simple model. This circuit consists of a voltage source in series with a capacitance. The open-circuit voltage is a product of the second-order coefficients and the square of the magnitude of the applied electric displacement field, and is in addition dependent on the applied microwave frequency. With a simple model used for the external network, the measurable voltage associated with the effect was determined. Direct comparison of theory and experiment was not possible since the model could not be applied to explain several observed effects. Microwave rectification has been achieved, however, by means of both polished and fine-ground X-cut quartz disks placed in the gap of a highly reentrant S-band microwave cavity. Author (TAB)

N67-36724*# National Bureau of Standards, Washington, D. C. Solid State Physics Section.
ELECTRONIC ENERGY BAND STRUCTURE OF SOLIDS
Quarterly Status Report, 16 Mar.–15 Jun. 1967
H. P. R. Frederikse 15 Jun. 1967 1 p refs
(NASA Order R-09-022-033)
(NASA-CR-88484) CFSTI: HC$3.00/MF$0.65 CSCL 20L

Studies of the piezoresistance and the piezo-Hall effect of semiconducting $SrTiO_3$ were continued. Preliminary measurements on a 110-sample with 3.2×10^{18} carriers per cm^3 showed the following results: (1) The piezoresistance at 300°K is very small and negative ($\approx -4\times10^{-7}$/atm); and the piezo-Hall effect is of the order of $+3\times10^{-5}$/atm. (2) At 78°K and at 4.2°K, the piezoresistance is much larger and positive; $\Delta\rho/\rho$ saturates for stresses of several hundred atmospheres at a level of 0.03 to 0.04. The change of Hall coefficient R_H with stress saturates also, but is negative (R_H decreases with compressive stress). Measurements of the conductivity and Hall effect of ceramic $BaTiO_3$ were also made. Also reported is the determination of the binding energy and effective masses of polarons as a function of the mass anisotropy. Results were applied to the case of $SrTiO_3$. S.C.W.

N67-36740# Lincoln Lab., Mass. Inst. of Tech., Lexington.
SOLID STATE RESEARCH AT LINCOLN LABORATORY
Quarterly Technical Summary Report, 1 Feb.–30 Apr. 1967
T. C. Harman et al 5 Jul. 1967 69 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-266; Rept.-2; AD-656548)

The report covers in detail the solid state research work at Lincoln Laboratory for the period 1 February through 30 April 1967. The topics covered are Solid State Device Research, Optical Techniques and Devices, Materials Research, and Physics of Solids. Author (TAB)

N67-36747# Army Electronics Labs., Fort Monmouth, N. J.
MICROWAVE PROPAGATION IN A SINGLE-CARRIER SEMICONDUCTOR, INCLUDING EFFECTS OF COLLISION AND DIFFUSION
Bruno Zotter Apr. 1967 36 p refs
(ECOM-2823; AD-654998)

The propagation characteristics of slow electromagnetic waves in a single-carrier semiconductor are derived under the small-signal assumption. The effect of a longitudinal magnetic field is included. The case of an infinite slab of finite thickness is treated for the case of metallic boundaries on both sides. The Brillouin diagram is shown for several values of collision and diffusion parameters, and the attenuation and instability regions are computed. The possibility of using a drifted semiconductor to interact with a slow-wave circuit for microwave generation and amplification is investigated. Author (TAB)

N67-36754# Fairchild Semiconductor Corp., Mountain View, Calif.
RADIATION STUDY ON MOS STRUCTURES Interim Scientific Report
E. H. Snow, A. S. Grove, and D. J. Fitzgerald Aug. 1967 43 p refs
(Contract AF 19(628)-5747)
(AFCRL-67-0381; SR-3; AD-656678)

Two effects of ionizing radiation on oxidized silicon surfaces have been reported: the formation of a space charge in the oxide and the creation of surface states at the oxide-silicon interface. In this report, the effects of processing variables--including substrate type, oxidation conditions, and gettering steps--on the above two phenomena are described. In addition, the effect of temperature on the rate of surface-state production is reported. High energy electron irradiations have been performed and the results compared to previous data taken with low energy electrons and X-rays. It is concluded that a given dose of any ionizing radiation has the same effect on the oxide space charge. Device studies have been extended to include junction field-effect transistors and it is concluded that these devices are less sensitive to ionizing radiation than either MOS or bipolar devices. Experiments with nuclear reactor irradiation show that in a reactor environment bulk damage due to fast neutrons dominates in the degradation of bipolar transistors, junction field-effect transistors, and p-n junction diodes, whereas, surface effects due to ionizing radiation present in the reactor are most important in the case of MOS transistors. Author (TAB)

N67-36784# Aerospace Corp., El Segundo, Calif. Electronics Research Lab.
DIAMAGNETIC AND PARAMAGNETIC SURFACE CURRENTS INDUCED BY TEMPERATURE CHANGES IN TYPE II SUPERCONDUCTORS IN STATIC MAGNETIC FIELDS
M. A. R. Le Blanc, D. J. Griffiths (Univ. of Southern Calif., Los Angeles), and B. C. Belanger (Univ. of Southern Calif., Los Angeles) May 1967 19 p refs
(Contract AF 04(695)-1001)
(TR-1001(9230-01)-3; SSD-TR-67-104; AD-655377)

We present evidence that a change in surface currents from critical paramagnetic to critical diamagnetic (or from critical diamagnetic to critical paramagnetic) is induced by a suitable increase (or decrease) of the temperature of a semireversible type II superconductor immersed in a static magnetic field H < H subscript c2. Author (TAB)

N67-36798 Liverpool Univ. (England). Dept. of Electrical Engineering and Electronics.
CHANGES IN THE ELECTRICAL RESISTANCE OF GOLD THIN FILMS DUE TO ION BOMBARDMENT
B. Navinsek and G. Carter [1963] 5 p refs

Gold films of 100 Å to 500 Å thickness were bombarded with energetic argon ions in order to measure changes in the electrical resistance. Polycrystalline gold films of about 1.0 cm^2 area were produced by evaporation, at a background pressure of < 10^{-7} Torr, on Pyrex substrates to which electrical contacts of

gold had previously been applied. An area of approximately 0.4 cm^2 of the film was then subjected to ion bombardment with monoenergetic A^+ ions derived from an rf ion source while maintaining the system background pressure in the 10^{-7} Torr region, although the argon pressure in the target region was 10^{-5} Torr. The A^+ ion energy could be varied between 400 eV and 2 keV, and the ion dose was varied up to 10^{18} ions/cm^2. Initial resistance and resistance after bombardment was monitored with a resistance bridge. Results are presented in graphs and are briefly discussed. K.W.

N67-36811# General Electric Co., Schenectady, N. Y. Research and Development Center.
EXPERIMENTS WITH LIQUID AND SOLID CESIUM ON A RHENIUM SUBSTRATE Interim Scientific Report
Harold F. Webster Jul. 1967 20 p refs
(Contract AF 19(628)-4339)
(S-67-1065; AFCRL-67-0334; SR-1; AD-656777)

Cesium metal was deposited from the vapor on a large-grained rhenium substrate. Both the wetting of the substrate by the cesium and the mode of growth of solid films of cesium are dependent upon the crystal face exposed by the various grains of rhenium. The experiment was done in a sealed-off glass tube which had a residual gas pressure of 10 to the -9th power *torr* before cesium was admitted. Both the wetting and the mode of film growth were dependent upon monolayer amounts of impurities. Epitaxial relationships were observed to exist between many of the rhenium grains and the deposited cesium. Author (TAB)

N67-36824# American Science and Engineering, Inc., Cambridge, Mass.
INVESTIGATION OF THE VARIABLES CONTROLLING THE FLUX GROWTH OF HIGH QUALITY LASER CRYSTALS Final Report, 20 Aug. 1965–19 Aug. 1966
Carolus M. Cobb and Elbridge B. Wallis 27 Mar. 1967 140 p refs
(Contract AF 19(628)-5656)
(ASE-1572; AFCRL-67-0196; AD-655388)

A study was made of the solution variables, crystal constants, and system parameters which control the growth of large perfect crystals of refractory oxides from fused salt solvents. A set of formulas were developed for the prediction of growth conditions from these fluxes. Cooling rates, thermal gradients, stirring rates, and container dimensions were considered as system parameters. Solubilities, diffusion constants, viscosities, interfacial surface energies, solution and crystal densities, and solute radii were considered as independent variables. The formulas were applied to the prediction of crystal growing conditions for the production of sapphire and ruby from a lanthanum fluoride-aluminum oxide flux. The study included experimental determinations of the densities and viscosities of the lanthanum fluoride-aluminum oxide flux and experiments upon the solubility of aluminum oxide in this flux. Results from the program indicate that past and present difficulties with the fused salt technique of crystal growth have been caused primarily by hydrodynamic factors which may be overcome by detailed planning of experimental growth conditions. Author (TAB)

N67-36865# Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.
ORIENTATION RELATIONS IN SIMPLE THIN FILM-SUBSTRATE COMBINATIONS
R. J. Gerdes and R. A. Young 15 Jul. 1967 48 p refs
(Contract Nonr-991(09))
(TR-6; AD-655652)

For oriented overgrowth in simple systems, the importance of a nucleation mechanism based on alignment of close-packed (CP) directions is assessed by a comprehensive review of the literature. Depending on temperature and crystalline character of the substrate, the mechanism results in either (1) alignment of CP-directions in the deposit with corresponding directions in the substrate or (2) maximization of the number of CP-directions in the deposit plane parallel to the interface. For FCC and HCP metals on NaCl-type and amorphous substrates, approximately 3,000 papers yielded some 600 usable reports representing 42 distinct orientation relationships. Eighty-six percent of the reports represented twenty orientation relationships accounted for by the CP-mechanism. Eight percent of the reports referred to four related orientations not accounted for by this mechanism. The remaining eighteen orientations were, for the most part, supported only by single observations. Thus the weak but long-range forces involved in the CP-mechanism appear to be of primary, though not sole, importance in the nucleation of oriented overgrowths in these simple systems. The observation information is presented in extensive tables. Author (TAB)

N67-36872# Army Electronics Labs., Fort Monmouth, N. J.
MEASUREMENT OF LINEWIDTH OF SINGLE CRYSTAL FERRITES USING A SHORTED TRANSMISSION LINE
I. Bady May 1967 51 p refs
(ECOM-2849; AD-656603)

A technique is described for measuring the linewidth of single crystals of ferrites which is accurate, rapid, easy to use, and can be readily adapted to give a visual display of the resonance curve. At C-band, the normalized equivalent resistance due to the ferrite sphere at resonance (expressed as a parallel component) agrees well with theory whether the sphere is undercoupled, critically coupled, or overcoupled to the transmission line. However, a substantial reactive component is present when the sphere is near critical coupling or overcoupled, and this is contrary to theory. It is concluded that measurement of linewidth should be taken under conditions where the sphere is substantially undercoupled. TAB

N67-36908# Iowa State Univ. of Science and Technology, Ames.
GRAIN BOUNDARIES IN CUBIC IONIC SOLIDS Final Report, 1 Jul. 1960–30 Jun. 1967
Thomas D. McGee and C. M. Dodd 17 Jul. 1967 9 p refs
(Contract DA-31-124-ARO-D-418)
(AD-655525)

This is a final report for research conducted on the ductility of cubic ionic solids in the transition from single crystal to the polycrystalline state. As such the project included research on single crystals, bicrystals, tricrystals, and polycrystalline specimens. Almost all of the work was conducted on NaCl as a structural model for MgO. Limited research was conducted on CaO, MgO, and LiF. Author (TAB)

N67-36963*# Naval Ordnance Test Station, China Lake, Calif. Naval Weapons Center.
THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE PHYSICS OF CRYSTALLINE SURFACES Quarterly Report, 1 Feb.–30 Apr. 1967
E. Bauer 30 Apr. 1967 4 p
(NASA Order R-05-030-001)
(NASA-CR-88611; QSR-1) CFSTI: $3.00 CSCL 20L

Progress is reported in various theoretical and experimental investigations of the physics of crystalline surfaces, such as: 1) The relation between the structure of epitaxial films and surface and interfacial energies. 2) Quantitative studies of the elastic and inelastic interactions of slow electrons with W single crystal surfaces. 3) Determination of nature and structure of surface layers with low energy electron diffraction. 4) Relation between structure and electron emission properties of work function reducing layers on W 110 surfaces. 5) Momentum exchange of atoms with well defined single crystal surfaces. R.Li

N67-36970*# Denver Research Inst., Colo.
THEORETICAL STUDIES ON THE RELATIONSHIP BETWEEN THE THERMIONIC WORK FUNCTIONS OF REFRACTORY-METAL INTERMETALLIC COMPOUNDS AND THEIR ELECTRONIC AND CRYSTAL STRUCTURES Final Summary Report
C. Samuel Miller 22 Sep. 1967 137 p refs
(Grant NsG-365)
(NASA-CR-88549; DRI-2418) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The Group VIA-Re binary systems are characterized by the presence of several intermediate phases. The σ phase is present in all of the systems, but the α-Mn phases occur in only the Mo–Re and W–Re systems. The occurrence of these intermediate phases appears to be governed largely by electronic factors and is predictable on the basis of electron/atom ratio. The thermionic work functions of the intermediate phase materials were experimentally determined. A correlation between the work function and the screening of the outermost electrons in the Group VIA metals was found. As might be expected for purely metallic substances, the work functions were relatively high, in the range 4.5 to 5.0 eV, and in each case were bracketed by the work functions of the pure constituents. A discontinuous change in the average work function with composition is proposed, based on a thermodynamical treatment of the electron vapor. Author

N67-37060# Case Inst. of Tech., Cleveland, Ohio.
ULTRASONIC EQUATION OF STATE OF TANTALUM
R. A. Chechile May 1967 24 p refs
(Contract Nonr-1141(05))
(TR-10; AD-655640)

The pressure derivatives of the elastic constants of a single tantalum crystal have been measured at room temperature by the ultrasonic pulse-echo technique. The values are: dC11/dP = 4.54 dC/dP = 1.03 dC prime/dP = 1.01 dBS/dP = 3.19. The notation C = C44, C prime = (C11 - C12)/2, BS = (C11 + 2C12)/3 has been used. The result expressed as the equation of state, = delta V/Vo = 0.526 x 10 to the -3 power - 0.581 x 10 to the -6 power P squared (pressure in kbar), agrees with the Bridgman 1949, 30 kbar, compression result when this is corrected by using the ultrasonic coefficients of iron. Author (TAB)

N67-37080# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
THE OPTICAL ABSORPTION EDGE IN THE LEAD SALTS AND ITS VARIATION WITH TEMPERATURE AND PRESSURE
Vidyut Prakash Jun. 1967 278 p refs
(Contract Nonr-1866(10))
(HP-13; AD-656591)

This report contains: a review of experimental and theoretical investigations of the band structure of the lead salts; a report of new measurements of the shift of the optical absorption edge in PbS, PbSe, and PbTe with hydrostatic pressure, and of the edge in PbS with temperature; a study of the shape of the absorption edge and its variation with temperature and pressure, particularly in PbS; and a study of the shape of the refractive index curve n(hv) near the absorption edge in PbS, and the shift of n(hv) with pressure and temperature. Author (TAB)

N67-37115# Pennsylvania Univ., Philadelphia. Dept. of Physics.
IONIC THERMOCURRENTS IN ALKALI HALIDE CRYSTALS CONTAINING SUBSTITUTIONAL BERYLLIUM IONS
Cesare Bucci Jul. 1967 30 p refs Submitted for publication
(Contract Nonr-551(28))
(TR-8; AD-656087)

The dielectric relaxations of NaCl and KCl single crystals containing beryllium ions were studied by using the technique of the ionic thermocurrents (ITC) in the range of temperatures between 1.2K and 300K. The ITC spectra are characterized by three types of relaxations in both host crystals. The analysis of such relaxations and the observed temperature dependence of their relaxation times indicate that: (1) the beryllium ions are, for a large fraction, associated with cation vacancies that occupy nearest neighbor (n.n) positions as well as next nearest neighbor (n.n.n) positions with respect to the impurity; (2) the relaxation rates with which the Be-vacancy dipoles change their orientation under the influence of an electric field are dominated by the frequency of direct interchange between Be and vacancy (omega-2) and by the frequency of jump between (n.n.) and (n.n.n.) positions (omega-3 and omega-4); (3) the activation energy for the diffusion of Be ions is .5 eV for NaCl and .45 eV for KCl. In discussing the results, the possibility that the Be ions occupy off-center positions is considered. Author (TAB)

N67-37192# Air Force Cambridge Research Labs., Bedford, Mass. Microwave Physics Lab.
TRANSMISSION LINE MODELS OF MAGNON–PHONON MODES IN FERRITES. PART II: COUPLED MODES
James C. Sethares May 1967 29 p refs *Its* Phys. Sci. Res. Papers No. 327
(AFCRL-67-0314; AD-655777)

In AD-641 638 uncoupled transmission line models for circularly-polarized shear waves and magnons in ferrites are described. Voltage and current variables are defined in terms of magnetic and mechanical variables and line elements are related to magnon-phonon parameters. Three models of coupled modes are now developed. The models are analytically equivalent but they differ in their physical interpretation. One model uses controlled sources as the coupling elements, and another uses a distributed transformer. Coupling in the final model is accounted for by line element modifications in the presence of mutual coupling. Boundary conditions for the distributed transformer coupling model are given. They include capacitive terminations on the magnetic line, a lumped transformer between magnetic and acoustic lines, and the loading of the combined system with a third acoustic line. These boundary conditions account for arbitrary acoustic loading of the magneto-acoustic media by a phonon supporting substrate and a range of boundary conditions between pinned and unpinned spin for the magnetic system. Distributed and nondistributed externally controlled sources may be placed anywhere in the coupled system. A Poyntings-type theorem for each model and expressions for group velocity, magneto-elastic resonant frequencies, and Qs are derived. A brief summary and conclusion which discusses various aspects of the coupled transmission line models is given. Author (TAB)

N67-37208# Sperry Microwave Electronics Co., Clearwater, Fla.
LOW MAGNETIC SATURATION GARNETS Final Report, 1 Feb. 1965–31 Jan. 1967
L. R. Hodges, Jr., W. R. Wilson, G. P. Rodrigue, and G. R. Harrison Ft. Monmouth, N. J., Army Electron. Command, Jun. 1967 226 p refs
(Contract DA-28-043-AMC-01205(E))
(SJ-220-0056-8; ECOM-01205-8; Rept.-8; AD-654999) CFSTI: HC $3.00/MF $0.65

A new family of single and polycrystalline low saturation magnetization garnets have been extensively investigated. The compositions, growth techniques, and results obtained from 72 single crystal runs of BiCaVIG and 24 crystal runs of YCaVIG are discussed in detail. An optimized process for growing BiCaVIG single crystals is described which has produced crystals of up to 1/2 inch in size from 250 gram melts. Linewidth and magnetization data are reported as a function of temperature for many of these

materials. Values of anisotropy field measured as a function of temperature are compared for BiCaVIG, YGaIG, and YIG. Potential device applications of BiCaVIG materials are evaluated by comparing their operating characteristics in a gyromagnetic coupling filter with those of YGaIG. Single crystal and polycrystalline BiCaVIG samples are also evaluated in an S-band Y-junction circulator. An optimized preparation procedure is described for processing single phase, low loss polycrystalline Bi and YCaVIG materials. Linewidth, magnetization, and geff factor are reported as a function of temperature for many of these compounds. Photomicrographs of both single phase and polyphase materials are presented for comparison purposes. Hybrid compositions containing Gd, Li, Al and Cu are discussed. Y-GdCaVIG materials possessed temperature stable magnetizations in the range of 200 to 800 gauss. TAB

N67-37233# Pennsylvania State Univ., University Park. Materials Research Lab.

FUNDAMENTAL STUDIES IN HIGH-TEMPERATURE MATERIALS PHENOMENA Annual Progress Report

M. E. Bell, L. E. Cross, L. N. Mulay, and G. R. Barsch Mar. 1967 37 p refs

(Contract AT(30-1)-2581)

(NYO-2581-7) CFSTI: HC $3.00/MF $0.65

Developments are reported for studies on dielectric, nonlinear elastic, and magnetic properties of inorganic salts, primarily TiO_2. Studies were also made on ordering of point defects in high temperature oxides. NSA

N67-37234# Franklin Inst., Swarthmore, Pa. Bartol Research Foundation.

SURFACE STRUCTURES AND WORK FUNCTION CHANGES IN OXYGEN ADSORPTION ON TUNGSTEN (100)

P. J. Estrup and J. Anderson 29 May 1967 11 p refs Submitted for publication

(Contract AT(30-1)-3830)

(NYO-3830-1; CONF-670320-4) CFSTI: HC $3.00/MF $0.65

Previous studies of O_2 adsorption on a W(100) surface were extended to include, besides LEED observations, measurements of work function changes and O_2 coverage. The evidence indicates that O_2 can interact in two distinct ways. At room temperature the adsorption occurs on top of an essentially undisturbed substrate. At higher temperatures O atoms can penetrate the surface and form reconstructed layers. Under various conditions several ordered structures are produced and the work function changes and surface coverage are correlated with these structures. Author (NSA)

N67-37256# Stanford Univ., Calif. High-Energy Physics Lab.

MICROWAVE MEASUREMENTS OF THE SURFACE IMPEDANCE OF SUPERCONDUCTING TIN AND LEAD

John P. Turneaure (Ph.D. Thesis) May 1967 84 p refs

(Contract Nonr-225(67))

(HEPL-507; AD-655452)

In this dissertation, the results of two different experiments are reported. In the first experiment, temperature dependent measurements were made of the surface impedance of superconducting tin and lead at 2.85 and 11.2 GHz; these surface impedance measurements were compared with the Mattis and Bardeen theoretical result, including a finite electron-pair coherence length and a finite electron mean free path. In the second experiment, temperature dependent measurements were made of the ac critical magnetic field of superconducting tin at 2.85 GHz; these ac critical magnetic field measurements were compared with dc critical magnetic field measurements. These two experiments stemmed from the program at Stanford University to develop a superconducting linear accelerator. Author (TAB)

N67-37273# Naval Research Lab., Washington, D. C.

DETECTOR INVESTIGATION FOR 8–15 AND 100–4000 MICRON REGIONS Final Report, 1 Jul. 1966–30 Jun. 1967

H. Shenker 26 Jul. 1967 44 p refs

(NRL-Memo-1789; Rept.-24; AD-656482)

Accomplishments in the following areas are summarized: impurity levels in germanium; magneto-optic effects in indium antimonide; Be-doped germanium detectors; preparation of Cd3As2 epitaxial films; Se-doped InSb Rollin detectors sensitive to wavelengths as short as 80 microns; magnetically tuned InSb detectors; liquid encapsulation method of zone refining; superheterodyne infrared radiometer systems. The report covers the work done during the period 1 Jan 67 to 30 Jun 67 only; for previous work see AD-628 870, AD-639 223, and AD-646 927. TAB

N67-37279# Illinois Univ., Urbana. Coordinated Science Lab.

SIZE EFFECTS IN THE TEMPERATURE VARIATION OF ELECTRICAL CONDUCTIVITY OF EPITAXIAL GOLD FILMS

J. T. Jacobs Aug. 1967 100 p refs

(Contract DA-28-043-AMC-00073(E))

(R-364; AD-656609)

Measurements of the resistivity of evaporated epitaxial gold films were made over the temperature range 4.2 to 300K. A computerized data analysis scheme, in which the operator played the part of a judgement element in the feedback loop, was used to fit the Fuchs-Sondheimer theory of size effects to the experimental data. The results for films thinner than 4000 A are that the degree of specularity, p, varied between 0.5 and 0.95, while the static lattice imperfection resistance, oi, varied between 5.2 and 9.0 x 10 to the minus 8th power ohm-cm. An anomalously high film resistivity in the temperature range 15 to 60K was observed. It was attributed to small angle electron-phon scattering. Data for films thicker than 4000 A could not be fit exactly to the Fuchs-Sondheimer theory below 15K and above 77K by a single set of the parameters p and o. The cause of this mismatch is unknown. Measurements on an 8.56 micron thick gold film indicate that the lattice resistivity between 8 and 20K varied as T4.4. The gold films, of thickness between 1300 A and 8.56 A, were vacuum deposited at rates in excess of 30 A/sec onto Tanganika muscovite mica held at 300C. The films were vacuum annealed before they were cooled to room temperature. They were removed from the vacuum and mounted in a liquid helium dewar. Measurements of thin film resistivity vs. temperature were automatically recorded on punched paper tape. A computer program was written to numerically calculate the Fuchs-Sondeimer integral for size effects on the electrical conductivity. This was incorporated into a curve fitting routine. A CDC 1604 computer was used to make the theoretical computations. These were superimposed on the experimental results and immediately displayed on a computer controlled ten-inch cathode ray tube. The operator changed the parameters until satisfactory agreement was obtained between the theory and the experimental data. Author (TAB)

N67-37339*# Texas Univ., Austin. Laboratories for Electronics and Related Science Research.

TUNNELING BETWEEN A METAL AND SILICON SEPARATED BY A POLYMER INSULATOR

Carl W. Wilmsen and William H. Hartwig 15 Sep. 1966 135 p refs

(Grants AF-AFOSR-766-66; NGR-44-012-043)

(NASA-CR-88716; TR-25) CFSTI: HC $3.00/MF $0.65 CSCL 20L

This research investigates tunneling between a metal and silicon separated by an insulator (MIS structure) and develops a model describing the MIS current–voltage characteristics. Analysis shows that any model for MIS tunneling must consider the density of surface states and the formation of a depletion or accumulation layer in the silicon. The model shows that the electric field in the insulator controls the MIS current while the charge distribution in

the silicon determines the insulator field. For the experimental results a polymerized silicone film formed the insulator. After establishing the technique of forming the polymer, metal–insulator (MIM) junctions enabled study of the electrical properties of the polymer and characterization of MIM tunneling currents. The MIM characteristics permitted comparative analysis with MIS structures. The experimental MIS curves on both N and P type silicon show the exponential dependence of current on voltage and they indicate that the mechanisms for MIM and MIS tunneling are quite similar. An asymmetric saturation of the MIS tunneling occurs. This is caused by the formation of a depletion layer on the semiconductor which forms after completely charging the surface states. Author

N67-37421* State Univ. of New York, Stony Brook.
THERMODYNAMIC PROPERTIES OF INTERSTITIAL ELEMENTS IN THE REFRACTORY METALS Semiannual Report, 1 Dec. 1966–31 May 1967
P. P. Bansal, N. C. Birla, A. C. Huang, and L. Seigle 31 May 1967 29 p refs
(Grant NGR-33-015-035)
(NASA-CR-88526; SAR-2) CSCL 20L

Values of the partial molar free energies, enthalpies, and entropies of C dissolved in solid Mo, W, Nb, and Ta were recalculated using new data concerning the location of the solvus lines in the respective metal carbon systems. These values were compared with those derived from the misfit energy theory, which correctly predicts the magnitude of the heats and entropies of mixing of C in these solid solutions. The thermodynamic analysis suggests that there is still uncertainty about the precise location of the solvus lines in the W–C and Ta–C systems. Author

N67-37429# University of Southern Calif., Los Angeles. Electronic Sciences Lab.
CONSOLIDATED SEMIANNUAL PROGRESS REPORT NUMBER 5, 1 OCTOBER 1966–31 MARCH 1967
31 Mar. 1967 224 p refs
(AD-656025)

Contents: Semiconductors; Quantum electronics; Magnetism; Crystals; Superconductivity; Metals; Applied electromagnetics and plasmas; Information sciences; Control systems; Communication systems; Hybrid and digital computation; Biological engineering. Author (TAB)

N67-37435# Oak Ridge National Lab., Tenn.
THE NEAR-SURFACE DIFFUSION ANOMALY IN GOLD
A. J. Mortlock Jul. 1967 16 p refs
(Contract W-7405-ENG-26)
(ORNL-4141) CFSTI: HC $3.00/MF $0.65

Co and Ni have been diffused at tracer concentrations in Au at several temperatures in the range from approximately 700 to 950°C. The diffusion penetration profiles were determined by a serial sectioning technique in which the Au is first anodized and then the anodic layer is dissolved in acid. In this way sections as thin as 250 A could be removed reproducibly. In all cases, the region close to the specimen surface was characterized by irregular behavior in the sense that the logarithm of concentration was not linear in the square of the penetration distance. In some cases, there was an indication of the operation of very slow diffusion in this region, while in others the apparent diffusion coefficient was negative. Possible reasons for this anomalous behavior are briefly discussed. Author (NSA)

N67-37500# Harvard Univ., Cambridge, Mass. Engineering and Applied Physics Div.
THE EFFECT OF PRESSURE ON OPTICAL ABSORPTION, RECOMBINATION RADIATION, AND RESISTIVITY OF GaSb
Bernard Brooks Kosicki Jun. 1967 163 p refs
(Contract Nonr-1866(10))
(HP-19; AD-656590)

The report described measurements of the effect of pressure on optical absorption, electroluminescence, photoluminescence and resistivity of GaSb. These measurements provide experimental values for two parameters of the GaSb energy band structure (pressure coefficient of the direct energy gap, and spin orbit splitting in the valence band at $k = 0$), and are analyzed to give information about Te, Se, and S donor impurity levels in GaSb. The effect of pressure on the resistivity of the n-type samples was measured; the observed increases in resistivity were much larger (especially in Se doped GaSb) than predicted by the increase in ionization energy of the Gamma 1 level mentioned above. Therefore, the presence of a second impurity level associated with the subsidiary L1 conduction band minima was invoked, and it was then possible to explain the observed increase in resistivity. From this and similar resistivity experiments on n-type GaSb the following impurity levels have been identified: Se and Te levels associated with the L1 conduction band minima, and Se and S levels associated with X1 conduction band minima. In each case, the apparent pressure coefficient of an impurity level was used to identify it with either the L1 or X1 conduction band. Author (TAB)

N67-37503# Naval Research Lab., Washington, D. C.
FERROMAGNETIC RESONANCE OF He^3-IRRADIATED THIN METAL FILMS
G. C. Bailey, A. I. Schindler, and P. H. E. Meijer (Catholic Univ. of Am.) 2 Jun. 1967 25 p refs
(NRL-6512; AD-655234)

Ferromagnetic-resonance measurements at 9.5 GHz were made on a number of films of pure iron and pure nickel, and alloys of iron and nickel (Permalloy) before and after 2-MeV He^3-particle irradiation. In general, H0 decreased (by about 2 oe, 35 oe, and 15 oe for the iron, Permalloy, and nickel films, respectively) as a result of the irradiation, except for the composition range between 26 and 37 percent Ni, where H0 increased. Also, the half-width generally decreased with irradiation. For the pure iron and nickel films, the changes in H0 can be attributed to changes in the radially isotropic stress in the plane of the film, and in the uniaxial anisotropic field. For the alloy films where irradiation-produced ordering may occur, Ms, as well as the above parameters, may also change. The changes in H0 were different for films of a given set evaporated onto various substrates (soft glass, fused quartz, single-crystal quartz, and copper). Irradiating a film (or reirradiating a previously irradiated film) in a magnetic field also rotated the easy axis of the film into the direction of the field applied during irradiation. The rotation of the easy axis was observed over the entire composition range from pure iron to pure nickel. For the pure iron and pure nickel films, the rotation can be explained only on the basis of alignment of defects in the film during irradiation. For the Permalloy films, a short-range directional ordering effect might also apply. The variation with composition of the values of uniaxial anisotropic field after irradiation agree qualitatively with the values obtained by others using static techniques. Author (TAB)

N67-37517# Los Alamos Scientific Lab., N. Mex.
BOSE–EINSTEIN CONDENSATION AND SUPERCONDUCTIVITY
Leonard W. Gruenberg 5 Jul. 1967 47 p refs
(Contract W-7405-ENG-36)
(LA-3600-MS) CFSTI: HC $3.00/MF $0.65

The Bardeen–Cooper–Schrieffer theory of superconductivity is discussed with an emphasis on its similarity to the theory of Bose–Einstein condensation in a charged Bose gas. Author (NSA)

N67-37541# Navy Electronics Lab., San Diego, Calif.
CONSTRICTED HYSTERESIS LOOPS OF BARIUM TITANATE: VARIATION OF POLARIZATION AND CURRENT DENSITY WITH TIME AND TEMPERATURE Research Report, Jun. 1962–Dec. 1963
G. W. Marks and R. D. Redin 20 Apr. 1967 38 p refs
(NEL-1455; AD-656585)

An empirical analysis was made of the change in polarization with time for a constricted hysteresis loop at fixed field strengths. Synthetic constricted loops were obtained by placing two polarized disks in antiparallel and applying a high alternating potential. The loops were studied by means of oscillograms taken during the deconstriction period. Hysteresis loop theory was extended and equations were derived that partially explain the results. Author (TAB)

N67-37545# Materials Research Corp., Orangeburg, N. Y.
INVESTIGATION OF ELECTRON BEAM PROCESSING OF ALUMINUM OXIDE AND RELATED MATERIALS Final Scientific Report, 15 Nov. 1965–15 Nov. 1966
W. Class, H. R. Nesor, and G. T. Murray 15 Dec. 1966 110 p refs
(Contract AF 19(628)-4089)
(AFCRL-67-0273; AD-656769)

The report is concerned with the application of float-zone crystal growth techniques to refractory non-metallic materials currently of interest to the laser technology. Electron beam and hollow cathode discharge techniques were used to produce the molten zones. The electron beam technique yielded sapphire crystals having diameters up to 5/16 in. Dislocation densities of 100/sq cm were observed. Ruby crystals having similar diameters were also grown, but reveal a pronounced chromium coring because of the large chromium losses which occur in the electron beam environment. The hollow cathode technique yielded sapphire, ruby and yttrium aluminum garnet crystals. Both pure and doped garnet crystals were grown. Multiply doped garnets containing erbium and holmium were produced which do not contain the flawed core exhibited by Czochralski pulled crystals. Only a limited amount of work was done related to ruby growth because of feed rod preparation problems. Author (TAB)

N67-37646# California Univ., Berkeley. Lawrence Radiation Lab.
INORGANIC MATERIALS RESEARCH DIVISION Annual Report, 1966
Mar. 1967 200 p refs
(Contract W-7405-ENG-48)
(UCRL-17330) CFSTI: HC $3.00/MF $0.65

Research progress is reported on studies concerned with inorganic chemistry, chemical thermodynamics, solid-state chemistry and physics, electrochemistry, physical chemistry, nuclear science, crystal imperfections, kinetics of dislocation mechanisms, relation of structure to properties in metallic systems, high strength materials, high field superconductivity, thermodynamics of metal systems, high temperature reactions, microstructure and behavior of ceramic materials and glass-metal systems, development and behavior of microstructures in ceramic systems, electric and magnetic properties of ceramic systems, and superconductivity in alloy systems. Research plans for solid state physics are briefly outlined. R.N.A.

N67-37665*# Texas Univ., Austin.
RESEARCH ON DIGITAL TRANSDUCER PRINCIPLES. VOLUME III: CHARGE TRANSPORT MECHANISMS IN THIN POLYMER FILMS, JULY 1, 1966–JUNE 30, 1967
Eugene T. Fitzgibbons and William H. Hartwig 30 Jun. 1967 65 p refs
(Grant NGR-44-012-043)
(NASA-CR-88843) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Electron currents between metal electrodes separated by an insulator are explained on the basis of field (tunneling) or thermal emission. Analytical expressions, based on a band-gap model of the insulator, are derived and discussed. Experiments were conducted on metal–insulator–metal junctions to determine the characteristics and develop, to a certain degree of sophistication, the technology of thin film devices. The junctions consisted of Al electrodes separated by a thin polymer film. The film was formed by polymerizing silicone diffusion pump oil, incident on the junction substrate with an electron beam. The voltage-current characteristics of the devices are highly dependent on insulator thickness and are understandable in the light of tunneling theory. For thicker samples, evidence indicated that field and thermal current mechanisms operate simultaneously. The slope and zero bias intercepts of the current–voltage curves yield data about the insulator. Author

N67-37713 Joint Publications Research Service, Washington, D. C.
TEMPERATURE DEPENDENCE ON THE DIELECTRIC CONSTANT OF MICAMUSCOVITE AT FREQUENCIES OF 50 CYCLES/SEC TO 1 MC/SEC
A. V. Mal'tsev and V. F. Berdinskiy 11 Sep. 1967 10 p refs Transl. into ENGLISH from Uch. Zap. Leningr. Ped. Inst. (Leningrad), v. 207, 1961 p 219–226
(JPRS-42539; TT-67-33167) CFSTI: $3.00

The test methods used in high temperature measurements of the mica dielectric constant are described. In most cases, temperatures were restricted at 500° to 520°C as the effect of dehydration and swelling of mica on the measured capacitances of the specimens is not significant; however, some measurements were made at 580° to 600°C. The results indicate: (1) The dielectric constant reduces with increased frequency. This decrease is more marked at higher temperatures and almost disappears at temperatures of 20° to 100°C. (2) At lower frequencies, in addition to ionic polarization, orientational polarization rises with increasing temperature; therefore, the value of the dielectric constant is observed to rise appreciably. (3) At higher frequencies, the dielectric constant of mica initially rises slowly with an increase in temperature; at 250° to 400°C, it decreases just as slowly. At temperatures above 500° to 540°C, an abrupt decrease in ϵ takes place. This is attributed to the failure to sufficiently account for swelling of the mica which, in turn, sharply reduces the measured capacitance value of the specimen. M.G.J.

N67-37768# Virginia Univ., Charlottesville.
DETERMINATION OF THE SURFACE STRESS OF GOLD
Claude Wayne Mays (M.S. Thesis) 10 Jun. 1967 54 p refs
(Contract AT(40-1)-3108)
(ORO-3108-28) CFSTI: HC $3.00/MF $0.65

The relationship between surface tension and surface stress is discussed. Equations relating these properties are derived. The surface stress of gold is determined by comparing values obtained for the lattice constants of different sized gold nuclei with those obtained for a continuous film of the same material. NSA

N67-37812 Lockheed Missiles and Space Co., Palo Alto, Calif.
FRACTURE DIAGRAMS OF SOLIDS
B. A. Drozdovskii, V. M. Markochev, and Ya. B. Fridman [1967] 5 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 174, no. 4, 1967 p 807–810

Construction of strain process diagrams is briefly reviewed. Crack length under instantaneous loading is considered. Three composite fracture diagrams for aluminum alloys are analyzed. These diagrams depict the dependence of the stress initiating the crack motion and the critical crack length stress. E.C.

N67-37844# Sandia Corp., Albuquerque, N. Mex.
COMPUTER PROGRAM FOR DAMAGE CORRELATION IN SILICON
C. W. Gwyn and J. L. Wirth Jun. 1967 31 p refs
(Contract AT(29-1)-789)
(SC-RR-67-122) CFSTI: HC $3.00/MF $0.65

The displacement damage produced in Si by neutron irradiation is a function of the neutron energy spectrum. The results of several studies performed to determine the energy dependence of displacement damage in Si are reviewed, and a computer code that is used to calculate the damage ratio for two arbitrary neutron spectra is described. Author (NSA)

N67-37864# Martin Co., Baltimore, Md. Research Inst. for Advanced Studies.
REBINDER EFFECTS IN MgO
Albert R. C. Westwood, David L. Goldheim, and Robert G. Lye Jun. 1967 29 p refs
(Contract Nonr-4162(00))
(RIAS-TR-67-6; TR-9; AD-655455)

A study was made of the effects of adsorbed complex ions and organic molecules of various dipole moments on the room temperature mobility of near-surface dislocation half-loops introduced by a diamond indenter into freshly cleaved MgO surfaces. In general, absorbed complexes of high charge (positive or negative), or molecules of high dipole moment, significantly enhance dislocation mobility, leading to the time dependent reductions in hardness termed anomalous indentation-creep. In certain environments, however, for example in aqueous 0.00001 N AgNO3, dislocation mobility is reduced. It is considered that both the latter effect, termed adsorption-locking, and anomalous indentation-creep effects belong to the class of phenomena known as Rebinder effects. Observations of a photomechanical effect in MgO, and of inhibition of enhanced mobility also are described. A possible explanation for Rebinder effects in ionic crystals is suggested. This is that chemisorption-induced band bending in the surface regions of the crystal alters both the electronic core structure (charge) of near-surface dislocations, and the state of ionization of point defects such as vacancies and impurities. As a consequence, the nature of the interactions between moving dislocations and such lattice defects is changed, affecting dislocation mobility and, hence, microhardness. The existence of Rebinder effects in metals is briefly discussed. Author (TAB)

N67-37866# Delaware Univ., Newark. Dept. of Physics.
SLOW MOVING FIELD DOMAINS IN CdS IN THE RANGE OF NEGATIVE DIFFERENTIAL CONDUCTIVITY
K. W. Boer and G. A. Dussel [Jul. 1967] 14 p refs
(Contract DA-31-214-ARO(D)-173)
(AROD-4461.19-P; TR-16; AD-656745)

Time periodic solutions of Poisson and transport equations in the range of negative differential conductivity due to field quenching were calculated by machine computation using parameters as obtained for cadmium sulfide and show the possibility that the hole concentration increases above the electron concentration in the high field domain. Author (TAB)

N67-37944*# Texas Univ., Austin.
RESEARCH ON DIGITAL TRANSDUCER PRINCIPLES. VOLUME IV: CHARGE TRANSPORT MECHANISMS IN THIN SILICON NITRIDE FILMS, JULY 1, 1966–JUNE 30, 1967
Jerry R. Yeargan, H. Lyndon Taylor, and William H. Hartwig 30 Jun. 1967 128 p refs
(Grant NGR-44-012-043)
(NASA-CR-88856) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The electric properties and behavior of thin silicon nitride films were investigated, emphasizing the conduction properties and mechanisms of the films on silicon and quartz substrates. The Poole–Frankel emission mechanism is discussed, and the transport mechanisms of thin film insulators are reviewed. Silicon nitride was deposited from the reaction of silane and ammonia. Details are presented on the growth rate, appearance, structure, dielectric constant, and current behavior. Results of the current behavior as a function of field, temperature, contacts, thickness, and substrates indicate the following conclusions: (1) The current varies as exp $(cV^{1/2})$ for fields up to 8×10^{6} V/cm. (2) The bulk properties control the current. (3) Field ionization occurs in the very high resistivity devices at fields above a $7–8\times^{6}$ V/cm. (4) The current depends strongly on temperature. Interesting but not directly related phenomena are also described. N.E.N.

N67-37959# Kiel Univ. (West Germany).
REACTOR-NEUTRON IRRADIATION OF SEMICONDUCTOR SINGLE CRYSTALS AT LOW TEMPERATURES AND ITS INFLUENCE ON HALL-EFFECT AND ELECTRICAL RESISTIVITY [REAKTORNEUTRONEN-BESTRAHLUNG VON HALBLEITER-EINKRISTALLEN BEITIEFEN TEMPERATUREN UND DEREN AUSWIRKUNG AUF HALL-EFFEKT UND ELEKTRISCHE LEITFAEHIGKEIT]
D. Wolf Apr. 1967 14 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-27)

Experiments are reported on Ge single crystals, irradiated at 77°K with fast reactor neutrons up to doses of 8×10^{12} nvt. Subsequent to irradiations isochronal and isothermal annealing curves have been recorded. Preparations to extend these experiments to higher neutron doses and to lower temperatures are described. Author (NSA)

N67-38020* Farnham (Frank C.) Co., Philadelphia, Pa.
ANISOTROPY IN THE THERMAL CONDUCTIVITY AND THERMOELECTRIC FORCE OF REGULAR METALS (TUNGSTEN) IN A TRANSVERSE MAGNETIC FIELD AT 20°K [ANISOTROPIE DER WARMELEITUNG UND THERMOKRAFT REGULARER METALLE (WOLFRAM) IM TRANSVERSALEN MAGNETFELD BEI 20°K]
E. Gruneisen and H. Adenstedt Washington, NASA, Jul. 1967 7 p refs Transl. into ENGLISH from Ann. Physik (Leipzig), ser. 5, v. 29, 1937 p 597–604
(Contract NASw-1497)
(NASA-TT-F-11079) CSCL 20L

The thermal conductivity and thermoelectric force of a pure tungsten crystal were measured in a liquid hydrogen bath (21.8°K) with and without a 6100-Oe magnetic field. In the magnetic field, the thermal conductivity dropped to a small fraction of its original value and the thermoelectric field also changed. Both of these characteristics are anisotropic in a magnetic field. Three different methods were used to show that an additive fraction, independent of the magnetic field, is contained in the thermal conductivity of tungsten, and this fraction is attributed to the lattice conductivity. Author

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N67-37226# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SOLID ROCKET PROPELLANTS

A. I. Silant'yev 24 Apr. 1967 66 p Transl. into ENGLISH of the Book "Tverdyye Raketnyye Topliva" Moscow, Voyennoye Izdatel'stvd, 1964 p 1–77
(FTD-MT-65-504; AD-658567)

The pamphlet is devoted to a semitechnical description of the compositions of rocket propellants, their energy (power) characteristics, and operational properties. TAB

N67-37244 Naval Ordnance Station, Indian Head, Md. Research and Development Dept.
RELATION BETWEEN PROPERTIES OF INGREDIENTS AND THEORETICAL PERFORMANCE OF PROPELLANTS, ESPECIALLY GAS-GENERATORS AND FLUORINE-CONTAINING PROPELLANTS
Albert H. Lapie, Martin F. Zimmer, and Edward E. Baroody [1967] 15 p Presented at the Symp. "Chem. Raketentriebwerke", Munich, Spring 1967
(Rept.-67-002)

To develop propellant formulations for special missions, it is desirable to have a method that clearly shows the effects of various ingredients on the theoretical performance of propellants. From statistical evaluation of theoretical-performance calculations of propellants with the elements C, H, N, O and C, F, H, N, O, respectively, relations were established between the heat of formation and oxygen balance of propellants and their theoretical performance in terms of specific impulse, chamber temperature, and solid-exhaust products. A new graphical method is described which enables the quick evaluation of propellant formulations by means of vector quantities assigned to each ingredient and the prediction of the influence of ingredients on the propellant. These relations are examined using examples involving (1) gas generator propellants and (2) fluorine-containing propellants. Author

N67-37539*# Stanford Research Inst., Menlo Park, Calif.
PHYSICAL PROPERTIES OF LIQUID OXYGEN DIFLUORIDE AND LIQUID DIBORANE: A CRITICAL REVIEW
J. S. Whittick, J. Neff, and R. F. Muraca 1 Jul. 1967 48 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951581)
(NASA-CR-88519; SRI-951581-4) CFSTI: HC $3.00/MF $0.65 CSCL 21I

A critical review of published information on the physical and thermodynamic properties of liquid oxygen difluoride and liquid diborane is presented. Original data are tabulated and accompanied by graphs to illustrate concordance or conflicts in the measurements and calculations of various workers. The values for each property are briefly discussed and suggestions are made for the validity of the data. Selected data for OF_2 and B_2H_6 are summarized and recommendations are made for the determination or re-determination of values for various physical properties. Author

N67-37633*# Aerojet-General Corp., Sacramento, Calif. Propellant Research and Development Div.
THE EFFECT OF SOLID PHASE REACTIONS ON THE BALLISTIC PROPERTIES OF PROPELLANTS
Willfred G. Schmidt 25 Sep. 1967 55 p refs
(Contract NAS1-6323)
(NASA-CR-66457) CFSTI: HC $3.00/MF $0.65 CSCL 21I

The decomposition of NH_4ClO_4, NH_4ClO_4 containing $KClO_3$ and NH_4ClO_4-transition metal chelate mixtures has been studied under both isothermal and nonisothermal conditions (in the latter case pressure, up to 1000 psi, was an additional variable). The experimental approach was essentially a chemical one and the NH_4ClO_4 decomposition was both accelerated and decelerated by additives and environmental conditions. These results were used in helping to determine the role of the condensed phase in the overall combustion of a composite NH_4ClO_4-fuel mixture. A mechanism is suggested for the decomposition of both catalyzed and uncatalyzed NH_4ClO_4 during the combustion of a composite NH_4ClO_4 propellant. Author

N67-37668# Purdue Univ., Lafayette, Ind. School of Aeronautics, Astronautics and Engineering Sciences.
STUDIES RELATED TO THE THERMOVISCOELASTIC STRESS ANALYSIS OF HIGHLY-LOADED SOLID PROPELLANT Final Technical Report, 1 Dec. 1965–30 Sep. 1966
R. A. Shapery, J. P. Vogt, and L. E. Clemmer Feb. 1967 134 p refs
(Contract AF 04(611)-11371)
(AA&ES-66-6; AFRPL-TR-67-106; AD-656347)

The report covers studies which account for realistic solid propellant properties, including nonlinear viscoelastic behavior, in the structural analysis of idealized configurations under slow cooling and ignition pressurization. First, approximate linear viscoelasticity solutions are given which illustrate certain essential features of propellant structural response, and demonstrate the applicability of quasi-elastic solutions. Specific nonlinear constitutive equations, for both mechanically compressible and incompressible materials, are then derived from a thermodynamic theory. An experimental program and data reduction scheme for evaluation of material properties is discussed. Application of nonlinear theory is made to long, hollow, case-bonded cylinders using actual propellant properties, and linear and nonlinear solutions are compared numerically. Author (TAB)

N67-37789* Rocketdyne, Canoga Park, Calif.
EVALUATION AND DEMONSTRATION OF THE USE OF CRYOGENIC PROPELLANTS (O_2–H_2) FOR REACTION CONTROL SYSTEMS. VOLUME I: CONCEPTUAL DESIGN AND ANALYTICAL EVALUATION Final Report
G. Falkenstein, D. Grubman, A. Liebman, and N. Rodewald Jun. 1967 383 p refs
(Contract NAS3-7941)
(NASA-CR-72176; R-6838-1) CSCL 21H

Results of a feasibility study of a cryogenic O_2–H_2 reaction control system are presented, including a conceptual design and a system analysis. Possible applications of such a system include propellant settling engines, attitude control, and secondary propulsion for upper stages, spacecraft, and orbital tankers. A system integrated with the tankage for a pump-fed main propulsion system (chamber pressure 10 psia) and a system fed from separate tankage (chamber pressure 100 psia) were investigated. Theoretical combustion performance and temperature characteristics were evaluated. The thrustors for such a system and a temperature and pressure conditioning subsystem were examined from a component standpoint. Concepts were evaluated for weight, volume, reliability, and state-of-the-art. One selected subsystem was modeled and the resulting equations were programmed for a digital computer. The program was used to simulate system and thrustor operation and to evaluate operating characteristics and control requirements. K.W.

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N67-36758*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CRYOGENIC POSITIVE EXPULSION BLADDERS
R. F. Lark Washington, NASA, 1967 22 p refs Presented at the 1st Ann. Cryog. Polymers Conf., Cleveland, 25–27 Apr. 1967
(NASA-TM-X-52353) CSCL 21H

NASA–LeRC in-house and contractual experimental programs were conducted to determine the cryogenic flexibility of single and multiple plys of thin polymeric films at −320° and −423°F. Results of cryogenic flexibility or "twist-flex" testing showed that thin Mylar films are the most flexible of the films tested. The relationships between cryogenic cycle-life and film thickness and also for the number of plys for Mylar film are reported at −320° and −423°F. Results of contractual testing of Mylar, Kapton and polyethylene film bladders at −423°F are summarized. Bladder material combinations showing the lowest helium gas porosity after 25 liquid hydrogen cycles are Mylar and an organic filament-reinforced polyethylene film laminate and Kapton/Nomex–Nylon. Author

N67-36857# Naval Ship Research and Development Center, Washington, D. C. Hydromechanics Lab.
THRUST AND BLADE SPINDLE TORQUE MEASUREMENTS OF FIVE CONTROLLABLE-PITCH PROPELLER DESIGNS FOR MSO 421 Final Report
E. Orm Hansen Apr. 1967 71 p refs
(DTMB-2325; AD-655636)

An experimental study is presented of the blade spindle torque of five controllable-pitch propeller models, representing five different designs for MSO-421. The study covers a range of both positive and negative advance coefficients at both ahead and astern pitch settings. It was found that the blade with spindle axis located 40 percent of blade width from the leading edge and with uncambered National Advisory Council for Aeronautics Series 66 (NACA 66) airfoil blade sections modified by the Bureau of Ships required the least extreme value of spindle torque. Author (TAB)

N67-36941*# Colorado State Univ., Fort Collins. Coll. of Engineering.
ADVANCED ELECTRIC PROPULSION RESEARCH Semiannual Report, Jan. 1–Jun. 30, 1967
W. R. Mickelsen Jul. 1967 278 p refs
(Grant NGR-06-002-032)
(NASA-CR-88419; Rept.-5) CSCL 21C

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N67-36942*# Colorado State Univ., Fort Collins.
ADVANCED CONCEPT IN ELECTRIC PROPULSION
William R. Mickelsen *In its* Advanced Elec. Propulsion Res. Jul. 1967 79 p refs (See N67-36941 22-28)

The relative merits of auxiliary electric propulsion systems are briefly outlined. Some advantages are: (1) capability of operation at a high enough specific impulse for the satellite mission requirements; (2) reduction or elimination of power conditioning; (3) reduction or elimination of power drawn from the solar-cell array; and (4) capability of precision thrust vectoring. Flight-prototype electric propulsion systems, experimental thruster systems, and advanced concepts are discussed and summarized under these four criteria. R.U.

N67-36943*# Colorado State Univ., Fort Collins.
PARTICLE CHARGING BY ELECTRON BOMBARDMENT
James P. Rybak and William R. Mickelsen *In its* Advanced Elec. Propulsion Res. Jul. 1967 17 p refs (See N67-36941 22-28)

On the problem of propellant efficiency in electric thrustors, particle charging by electron bombardment is considered. It is assumed that the charging process occurs after the particles have been formed and that the charging mechanism employed is that of positive ionization due to electron bombardment. Because of the uncertainty concerning the nature of the particles, three distinct cases are investigated, under which the particle at the time of charging can be considered to be (1) a dense vapor, (2) a liquid droplet, and (3) a solid particle. Pertinent graphics are included. R.U.

N67-36944*# Colorado State Univ., Fort Collins.
ELECTROTHERMAL THRUSTERS IN THE ATEP SYSTEM
Daniel C. Garvey and William R. Michelsen *In its* Advanced Elec. Propulsion Res. Jul. 1967 39 p refs (See N67-36941 22-28)

To increase thrustor specific impulse, a preliminary examination of the ideal performance of a propulsion system with electrothermal thrustors is described. Application of electrothermal thrustors to this concept requires the addition of heat to a supersonic stream, and lithium was selected as the propellant for this analysis because of its advantages as a reactor coolant. Employing the mathematical relations of Crocco, several cases of heat addition to a supersonic stream are considered. While facilitating the preliminary analysis, the Crocco relation is a restricted approach to the concept of heat addition to a supersonic stream. Further study is indicated. R.U.

N67-36945*# Colorado State Univ., Fort Collins.
FUNDAMENTAL PLASMA PROCESSES IN ELECTRON-BOMBARDMENT-THRUSTER IONIZATION CHAMBERS
Rodney T. Hodgson, Dennis C. Fitzgerald, and William R. Mickelsen *In its* Advanced Elec. Propulsion Res. Jul. 1967 27 p refs (See N67-36941 22-28)

In an attempt to obtain a more detailed understanding of the processes taking place in electron bombardment thrustors, and to develop a model to predict and optimize thrustor performance, an experimental and theoretical program of investigation of plasma characteristics was initiated. The current density distribution in an electron bombardment thrustor is also described, as well as the feasibility of measuring the current density distribution in the bombardment chamber by measuring the changes in the magnetic field produced by these currents. R.U.

N67-36946*# Colorado State Univ., Fort Collins.
APPROXIMATE METHODS IN ELECTRIC PROPULSION MISSION ANALYSIS
W. R. Mickelsen and C. B. Winn *In its* Advanced Elec. Propulsion Res. Jul. 1967 37 p refs (See N67-36941 22-28)

An approximate analysis of the Mars Orbiter Lander is presented in mathematical terms. An essential characteristic of

this method is that it be independent from the accurate methods; and, to provide true flexibility only the fundamental properties of the solar system are considered in evaluating any mission profile. It is emphasized that this analysis is based on the concept of ttt-to-rest motion in field-free space. R.Li.

N67-36947*# Colorado State Univ., Fort Collins.
ALUMINUM COLLOID FORMATION BY HOMOGENEOUS NUCLEATION IN A SUPERSONIC NOZZLE
Harry I. Leon, Fariborz P. Saheli, and William R. Mickelsen *In its* Advanced Elec. Propulsion Res. Jul. 1967 31 p refs (See N67-36941 22-28)

Research was directed toward the development of a charged particle electrostatic thrustor that can operate with aluminum propellant. The principles involved in aluminum colloid formation in a supersonic nozzle are outlined, and parameter studies made on the important variables to help determine the optimum nozzle design are included. R.Li.

N67-36949*# Colorado State Univ., Fort Collins.
THE PRODUCTION OF CHARGED-PROTEIN IN MOLECULES BY ELECTROSTATIC SPRAYING
Vivian Steadman and G. W. Tompkin, Jr. *In its* Advanced Elec. Propulsion Res. Jul. 1967 9 p refs (See N67-36941 22-28)

The research is designed to produce a charged colloid beam, the particles of which contain protein and a solvent; the specific charge desired is one greater than about 1000 coul/kg. The method of charged particle production is that of induction charging, by which the charged droplets are created at the tips of a needle into which the propellant is introduced and to which a high voltage, either positive or negative, is applied. A number of criteria are listed that have evolved as most conductive to the production of charged droplets having a narrow specific charge distribution by induction charging. These criteria and the additional factors of mass flow rate, properties of the doping additive, and the potential difference between the needle and extractor determine the magnitude of the peak of the specific charge distribution. Increase in spraying potential, increase in doping additive concentration, and decrease in reservoir pressure each increase the specific charge of the propellant. A few of the hypotheses which have been advanced to explain the origin of some of the observed dependencies of the specific charge distribution on the above-mentioned factors are also given. R.Li.

N67-37107*# General Electric Co., Lynn, Mass. Advanced Technology and Demonstrator Programs Dept.
SINGLE STAGE EXPERIMENTAL EVALUATION OF HIGH MACH NUMBER COMPRESSOR ROTOR BLADING. PART 2: PERFORMANCE OF ROTOR 1B
D. R. Seyler and J. P. Gostelow 22 Sep. 1967 91 p refs
(Contract NAS3-7617)
(NASA-CR-54582; GE-R67FPD236) CSCL 21E

A 1,400 foot per second tip speed rotor with a 0.5 hub-tip radius ratio, designed to deliver a total pressure ratio of 1.60 and a rotor adiabatic efficiency of 0.858 at a flow of 215.49 lbs/sec, was tested with and without inlet distortion. A rotor total pressure ratio of 1.638 and an adiabatic efficiency of 0.895 at a flow of 219.2 lbs/sec were actually achieved. Author

N67-37120# Aeronautical Research Council (Gt. Brit.).
THE DEVELOPMENT OF INJECTOR UNITS FOR JET-LIFT ENGINE SIMULATION ON LOW-SPEED-TUNNEL MODELS
M. N. Wood and J. B. W. Howard London, HMSO, 1967 18 p refs Supersedes RAE-TR-65020; ARC-26897
(ARC-REM-3464; RAE-TR-65020; ARC-26897) CFSTI: HC $3.00/MF $0.65

Small-scale injector units have been developed for providing the engine nacelles of V/STOL models, with both intake and exit flows. The primary energy supply was cold compressed air at pressure ratios up to 4:1. With the chosen injector arrangement, a stable and uniform exit velocity distribution was achieved, with a mean velocity of nearly 650 ft/sec, and almost 50 per cent of the jet efflux drawn in through the intake. The requirements for engine simulation on model scale, and the capabilities and limitations of injector units for this application are discussed in an appendix. Author

N67-37213* Rocketdyne, Canoga Park, Calif.
AXIAL PUMP ROTORDYNAMIC STUDY Final Report
R. D. Graham, B. F. Rowan, and F. A. Shen 1 Oct. 1967 388 p refs
(Contract NAS3-7996)
(NASA-CR-72302; R-6982) CSCL 21H

Effort was divided between development of the analytical models and simulation of the experimental data of Mark 9 pump tests. During the course of the simulation, shortcomings were noted in the initial model. Following the removal of simplifying assumptions, data simulation and the parametric study were performed. Analytical results and conclusions drawn from the study as well as derivations of the model equations used are presented. The development and programming of a generalized digital flexible rotor model are also presented. Recommendations are made toward additional research to further develop the analytical models. Author

N67-37282* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
NONLINEAR COMBUSTION INSTABILITY IN LIQUID-PROPELLANT ROCKET ENGINES. THE TRANSVERSE MODE. I. THE HYDRODYNAMIC DIFFERENTIAL AND DIFFERENCE EQUATIONS AND COMPUTER ALGORITHM
Samuel Z. Burstein 15 Sep. 1967 50 p
(Contract NAS7-100)
(NASA-CR-88763; JPL-TR-32-1111) CSCL 21B

Detailed information is presented on a numerical technique for the time-dependent integration of the complete nonlinear equations of inviscid fluid dynamics. A description of the time-dependent partial differential equations with some outstanding characteristic features is followed by a description of the difference approximations of second-order accuracy to these differential equations. The theory is completed with a discussion of the nature of weak solutions to these differential equations, i.e., solutions which contain shocks. The method of calculation carried out in the computer code Comb and the description input data preparation and format of output data are also given. The code Comb, written in Fortran IV, is designed to integrate the inviscid fluid dynamic equations in two cylindrical space coordinates r, θ and time t. The technique of solution is referred to as a two-step Lax–Wendroff method. A complete listing of the program is given. Author

N67-37371*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
SINGLE STAGE EXPERIMENTAL EVALUATION OF SLOTTED ROTOR AND STATOR BLADING. PART VII: DATA AND PERFORMANCE FOR SLOTTED STATOR 2
28 Sep. 1967 97 p refs
(Contract NAS3-7603)
(NASA-CR-54550; PWA-FR-2287) CSCL 21E

A single-stage investigation of a slotted stator was conducted as part of an overall program to evaluate the effect of slots on the performance of highly loaded compressor rotor and stator blade rows. A lightly loaded flow generation rotor was used to provide stator inlet flow. The stator vanes were 65-series airfoils of constant spanwise camber and blade chord angle. The design

diffusion factor for the unslotted vanes at a radial position 90% of the span from the vane tip was 0.596 at an inlet Mach number of 0.644. The measured total pressure loss in the stator root region was considerably higher than the predicted loss due to secondary flow effects. Author

N67-37820# Little (Arthur D.), Inc., Cambridge, Mass.
FLAME-PILOTING MECHANISMS IN LIQUID PROPELLANT ROCKET ENGINES.
Aubrey C. Tobey and E. Karl Bastress Oct. 1966 73 p refs
(Contract AF 49(638)-1120)
(AFOSR-67-0938; AD-655792)

A program was directed toward the systematic investigation of flame-piloting mechanisms in liquid rocket engines and their role in combustion instability. The mechanism which gained the most attention was recirculation. The program included experimental analysis of rocket engine performance as affected by external disturbances, minor geometry changes, and propellant state changes; and theoretical analysis of mixing in chemically reacting systems. Principal conclusions drawn from the results of the program are: (1) Characteristics of the injector and of the propellants are principal factors in the chemical kinetics and fluid dynamics within rocket engine combustors. (2) For the rocket engine and perturbation technique used, engine stability is unaffected by perturbations of the recirculation zone. This does not necessarily eliminate the process of recirculation as a factor in engine stability. Author (TAB)

N67-37852# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.
STATIC AND DYNAMIC INSTABILITIES OF A PROPELLANT LINE Interim Scientific Report
Alan S. Greenwald and John Dugundji May 1967 64 p refs
(Contract AF 49(638)-1528)
(ASRL-TR-134-3; AFOSR-67-1395; AD-656752)

The static and dynamic instabilities of cantilever propellant lines with flowing fluid are investigated experimentally and theoretically. Experimentally, three different cantilever propellant lines were tested. Above a critical fluid velocity, flutter was observed in the form of traveling waves moving down the line. Static divergence was also observed at lower fluid velocities when the free end of the cantilever was pinned. Movies were taken exhibiting clearly the onset of flutter and divergence. Theoretically, two and four mode Galerkin solutions with different types of structural damping forces were obtained. Theory confirmed previous investigators observations of sharp changes in flutter behavior at certain values of mass ratio and significant effects on stability caused by the type of structural damping present. Reasonably good agreement was found between the experimental flutter and divergence phenomena, and the theory. Using these and previous investigations results, design curves are presented allowing quick estimates of the static and dynamic instability of such propellant lines. Author (TAB)

N67-37626* Scientific Translation Service, La Canada, Calif.
TWO MODES OF OPERATION OF A COMBUSTION CHAMBER MODEL AS A SELF-OSCILLATING THERMOACOUSTIC SYSTEM [O DVUKH REZHIMAKH RABOTY MODEL'NOY KAMERY SGORANIYA KAK TERMOAKUSTICHESKOY AVTOKOLEBATEL'NOY SISTEMY]
V. Ye. Doroshenko, S. F. Zaytsev, and V. I. Furletov Sep. 1967 11 p refs Transl. into ENGLISH from Zh. Prikl. Mekhan. i Techn. Fiz. (Moscow), no. 1, Jan.-Feb. 1967 p 64-70
(Contract NASw-1496)
(NASA-TT-F-11288) CSCL 21B

Soft and hard oscillation modes of a combustion chamber were investigated experimentally. Oscillation hysteresis and the sudden appearance of transverse acoustic waves are examined. Author

N67-37634*# Aerojet-General Corp., Sacramento, Calif. Materials Advanced Technology Dept.
INVESTIGATION OF ADVANCED REGENERATIVE THRUST CHAMBER DESIGNS Interim Report
V. R. Stubbs, H. M. Evensen, E. W. Fraczek, and J. A. Cunningham Aug. 1967 201 p refs
(Contract NAS3-7971)
(NASA-CR-72266) CSCL 21H

A regenerative thrust chamber design is presented which consists of a refractory metal flame liner, a thermal barrier, nickel inner and outer shells, and integral nickel ribs to form the coolant channels. Potential materials, fabrication methods, and processes are analyzed and the selection of chemical vapor deposited tungsten for the flame liner, plasma-arc sprayed tungsten–zirconia composites for the thermal barrier, and electroformed nickel for the structure is justified on the basis of applicability to the design and the potential for future development. Complete stress and heat transfer studies were performed for the design, and a fabrication analysis was made to confirm the producibility of the overall design. Author

N67-37657*# TRW Systems, Redondo Beach, Calif.
A PROGRAM TO DEVELOP HIGH PERVEANCE IONIZERS
John C. Beynon and P. W. Kidd 1 Sep. 1967 181 p refs
(Contract NAS3-7106)
(NASA-CR-54693; TRW-4440-6009-R000) CFSTI: HC $3.00/MF $0.65 CSCL 21C

Work has consisted of the evaluation of several accelerator electrode materials for their compatibility with a cesium contact ion engine. Pure metals such as beryllium, iron, nickel, and copper were tested as well as several alloys including cupro-nickel, copper irridium, and nickel–iron alloys. All of the above mentioned elements appear to be compatible with the contact engine. Six life tests were made; four with copper electrodes and two with nickel. Both are quite satisfactory materials for the engine design. Although these tests ranged in duration from 100 to 524 hours, the neutral fraction was generally high. Equivalent operating time with an emitter yielding a 1% neutral fraction ranged between 770 and 7800 hours. From this data (and additional sputtering experiments) the end life of a nickel electrode in a 1% neutral environment, best state of the art emitter contouring accuracy, and an ion current density of 17 ma/cm^2 would be a minimum of 10,000 hours. One very encouraging development in connection with the contact ion engine has been the identification and control of a recurrent "poisoning" problem which invariably led to high neutral fractions and high operating temperatures. Author

N67-37694*# Aerojet-General Corp., Sacramento, Calif.
TWO HUNDRED SIXTY-IN.-DIA. MOTOR PROGRAM Final Report
5 Jun. 1967 98 p refs
(Contract NAS3-7970)
(NASA-CR-72287) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Static test firing of the 44-SS-4 motor is reported, including normal motor and nozzle performance for every parameter over the entire test duration. Post-test condition of the nozzle liner and insulation was excellent, and accumulated data verify positive margins of safety through the 260-SL-3 nozzle assembly. Measured average material erosion and ablation at the nozzle throat was 0.040 in, which resulted in a material loss rate of 0.0033 in/sec over the 12.1 sec web-action time. Erosion at the nose section averaged 0.10 in, and there were selective higher losses adjacent

to the grain valleys; while erosion in the throat section was negligible. Measured chamber pressure was 606 psia as compared to a predicted 580 psia; and this is attributed primarily to a propellant burning rate scale-up effect. M.W.R.

N67-37790* Minnesota Univ., Minneapolis.
STUDIES RELATED TO THE DEVELOPMENT OF A MULTIPLE START–STOP SOLID PROPELLANT ROCKET MOTOR
Roger A. Paulson (M.S. Thesis) May 1965 88 p refs
(Contract NAS3-2554)
(NASA-CR-72313) CSCL 21H

A small solid propellant rocket motor with multiple start–stop capabilities was constructed and operated in ambient atmosphere with highly aluminized ammonium perchlorate annular propellant grains. The ignition and quenching devices allowed multiple firings of the motor without intermittent servicing, and chlorine trifluoride and electric flare ignitors were used. The rapid exhausting of chamber pressure was used for quenching. The Kel-F grease used as a sealant and lubricant on the rotating injector core caused sticking and leakage. The quick-opening valve used for obtaining rapid pressure decays could immediately be reset for subsequent ignitions. The combustion gases were exhausted symmetrically at 90° to the motor axis through 10 exhaust ports. Standard O-rings of Buna-N usually provided good static and dynamic seals. Secondary total quenches with chlorine trifluoride ignited motors were somewhat harder to obtain than were total quenches with electric flare ignited motors. It was concluded that this was probably due to chlorine trifluoride trapped in the nooks of the injector. A heat transfer model was constructed to calculate the temperature-time history of a recently quenched grain. Author

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N67-36712*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.
SPECTRAL, SPATIAL, AND TEMPORAL VARIATIONS OBSERVED FOR OUTER ZONE ELECTRONS FROM 10 TO 100 keV WITH SATELLITE INJUN 3
Theodore A. Fritz (Ph.D. Thesis) Aug. 1967 201 p refs
(Grants NsG-233-62; Nonr(G)-1509-06)
(NASA-CR-88542; Rept.-67-42) CSCL 04A

Spectral, spatial, and temporal variations of outer zone electrons with energies from 10 keV to 100 keV observed with Injun 3 are presented. Electrons with $E_e \geq 40$ keV were constantly observed precipitating into the atmosphere for all latitudes, $\Lambda \geq 45°$. At latitudes below the high latitude boundary, the flux of ≥ 40 keV electrons in the loss cone was observed to always be $\approx 10^{-2}$ that of the locally mirroring flux. There was usually a spike of precipitating ≥ 40 keV electrons observed at the high latitude boundary and the flux of ≥ 40 keV electrons was usually observed to approach isotropy over the upper hemisphere at the position of the satellite at this boundary. Large intensities of electrons with energies not much greater than 40 keV were observed precipitating into the atmosphere for $\Lambda \geq 65°$ during magnetically quiet periods and the position of the high latitude outer zone boundary (intensity cutoff) was observed to vary by $\Delta\Lambda \approx 7°$ while *no* magnetic activity was occurring. The latitude where the ratio of the trapped to the precipitated ≥ 40 keV particle fluxes breaks from 10^{-2} toward one is introduced as a more meaningful concept of the high latitude limit to durably trapped ≥ 40 keV electrons than the usual intensity cutoff. Author

N67-36845# Harvard Coll. Observatory, Cambridge, Mass. Solar Dept.
RESEARCH DIRECTED TOWARD THE OBSERVATION AND INTERPRETATION OF SOLAR PHENOMENA Final Report, Mar. 1, 1964–Apr. 30, 1967
Barbara Bell, Howard L. deMastus, and Donald H. Menzel May 1967 33 p refs
(Contract AF 19(628)-3322)
(AFCRL-67-0346; AD-656751)

The first section describes research at Harvard in the following major categories: (1) Solar-terrestrial studies, relating geomagnetic distrubances and shortwave radio fadeouts to aspects of solar activity, and investigating a possible influence of phase of the moon upon solar-terrestrial correlations. (2) Analysis of solar observations made at Sacramento Peak and elsewhere of prominences, sunspots, and the green coronal line. (3) Theoretical studies in magnetohydrodynamics, leading toward development of a model for sunspots; and in atomic theory, on the intensities of spectral lines for improved interpretation of the solar spectrum. The second section reviews the operation at Sacramento Peak of the optical solar patrols of flares in the light of H alpha, of sun spots in white light, and of the coronal emission lines. The calibration of the coronal spectrograph is discussed, and the Sacramento Peak scale compared to that used at other observatories. A cooperative effort, begun in 1964, between the Harvard patrol group at Sacramento Peak and the USAF Air Weather Service is described, including a training course program. TAB

N67-36848# Oslo Univ., Blindern (Norway). Inst. of Theoretical Astrophysics.
AN ISOPHOTOMETRICAL STUDY OF WIGGLES IN THE SOLAR IRON LINES
Einar Haugen 3 Jan. 1967 35 p refs Reprinted
(Contract AF 61(052)-743)
(AFCRL-67-0354; SR-14(63); Rept.-20; AD-656770)

Marked asymmetries are observed in the profiles of moderately strong and weak iron lines near the centre of the solar disk. These asymmetries are shown to vary strongly from point to point on the sun. The properties of the asymmetries are discussed. The observations show that large scale irregularities of the order of 100,000 km may be present in the solar photosphere. Comparison of simultaneous observation of lines of different intensity indicates that the lines are shifted relative to each others, in the sense that the stronger lines are shifted more to the red than the weaker ones. This difference between weak and moderately strong lines have been found in spectra obtained at two different observatories. If the difference in line shift between different lines is interpreted as doppler shift, velocities up to 1 km/sec are found. Author (TAB)

N67-36896# Minnesota Univ., Minneapolis. School of Physics and Astronomy.
THE ENERGY SPECTRUM OF THE Z>20 COMPONENT OF THE COSMIC RADIATION
P. S. Freier and C. J. Waddington Jun. 1967 16 p refs Presented at the 10th Cosmic Ray Conf., Calgary (Canada)
(Contract Nonr-710(60))
(CR-99; AD-656432)

Three large stacks of nuclear emulsions were exposed during 1964-1966 on high altitude balloons launched from Fort Churchill, Canada; Texas, U.S.A.; and Hyderabad, India. These stacks have been used to study the energy spectrum of the cosmic ray nuclei of

calcium and heavier, the so-called VH-nuclei. These measurements result in integral intensity values for energies greater than 7.1, 1.58 and 1.00 GeV per nucleon, together with differential intensities over the range 225 less than E less than 1000 MeV per nucleon. Differential intensities were also found for lighter nuclei over varying energy ranges. The differential spectrum observed has a maximum value of about 0.0016 nuclei/sq m ster. sec. MeV per nucleon around E approximately equals 350 MeV per nucleon and falls off at both higher and lower energies. These values are based on the observation of a total of some 1600 VH-nuclei. The energy spectrum has been compared with that observed at similar times for the helium nuclei in order to study the influences of ionization energy losses during propagation of these high Z nuclei. These observations are interpreted as implying that if the source spectra of the VH-nuclei and the helium nuclei are similar then the VH-nuclei have traversed less than 1 g/sq cm of matter while ionization energy loss has been the dominant acceleration term. Author (TAB)

N67-36929# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

RADIATION BELTS OF THE EARTH

P. V. Vakulov, Ye. V. Gorchakov, and Yu. I. Logachev 18 Apr. 1967 138 p refs Transl. into ENGLISH of the book "Radiatsionnyye Poyasa Zemli" Moscow, Nauka, 1965 p 1–114
(FTD-MT-65-417; TT-67-62362; AD-655364)

The translation describes the investigations of radiation, carried out by a group of colleagues of Moscow State University and the Physical Institute of the Academy of Sciences of the USSR under the leadership of S. N. Vernov and A. Ye. Chudakov, with the help of Soviet artificial earth satellites and space rockets launched in the (IGY) period during 1957–1959. For the considered period in the Soviet Union investigations of radiation were produced using two artificial satellites and three space rockets. As a result, considerable experimental material has been accumulated which has nowhere been systematically published. The subsequent chapters give a survey of results of these investigations, a detailed description of the equipment used, and the methods of transmission. TAB

N67-36978# Minnesota Univ., Minneapolis. School of Physics and Astronomy.

THE CHARGE DISTRIBUTION OF THE ENERGETIC VERY HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION

O. Mathiesen, C. E. Long, P. S. Freier, and C. J. Waddington [1967] 15 p refs Presented at the 10th Cosmic Ray Conf., Calgary (Canada)
(Contract Nonr-710(60))
(CR-100; AD-656433)

A fully digitized, semi-automated photodensitometer has been employed to study the detailed charge composition of primary cosmic ray nuclei having Z less than 16 detected in a stack of nuclear emulsions flown from Hyderabad, India under approximately 4g/sq cm of residual atmosphere. One hundred and twenty nuclei heavier than phosphorus have been analyzed. These nuclei all had energies exceeding 7.1 GeV per nucleon and have had their charges measured with an accuracy estimated to be plus or minus 0.4 of a unit charge. It has consequently been possible to resolve the individual charges and to determine the elemental abundances. The observed charge distribution has been corrected to the top of the atmosphere and compared with various cosmological abundance compilations. After deriving values for the fragmentation parameters in hydrogen, it is concluded that the data are consistent with the charge distribution predicted if an initially pure example of iron nuclei had traversed some 4 g/sq cm of matter since the initial acceleration. The cosmologically abundant elements sulphur, argon and calcium appear to be relatively absent from the source, while nickel is only present with the predicted abundance. Author (TAB)

N67-37079*# Harvard College Observatory, Cambridge, Mass.

A SOLAR IRON ABUNDANCE DETERMINATION USING LINES IN THE NEAR UV

George L. Withbroe Mar. 1967 47 p refs
(Grant NsG-438)
(NASA-CR-88743; SR-17) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Lines of Fe I located between 3100 and 3800 Å are used to determine the solar iron abundance. We find an abundance that is a factor of four smaller than the photospheric abundance determined from lines in the visible part of the spectrum. Possible explanations for this apparent discrepancy are discussed. Author

N67-37191*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE SOLAR CORONA ABOVE ACTIVE REGIONS: A COMPARISON OF EXTREME ULTRAVIOLET LINE EMISSION WITH RADIO EMISSION

Werner M. Neupert Mar. 1967 47 p refs
(NASA-TM-X-55922; X-614-67-90) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The observation of extreme ultraviolet emission lines of Fe IX through Fe XVI made by OSO-1 are discussed and applied to a study of the solar corona above active regions. Both radio emission and line radiation from Fe XVI, the highest stage of ionization of Fe observed, are observed to increase rapidly with the onset of activity and are most intense over an E spot group early in the lifetime of the active region. As activity diminishes, radiation from Fe XV and Fe XIV becomes relatively more prominent. The observations imply that the coronal temperature reaches a maximum during the period of highest activity, as indicated by sunspot group complexity and the occurrence of chromospheric flares. A maximum coronal temperature of $3.8–10^{6}$°K is estimated when taking into account the mechanism of dielectronic recombination. Concurrently, the coronal electron density increases by a factor of 10–12. Both electron temperature and density decrease as activity subsides. A value of $2.5–3.0\times10^{6}$°K is obtained after flare activity has ceased and sunspots have disappeared. Author

N67-37283*# TRW Systems, Redondo Beach, Calif. Space Sciences Lab.

SOLAR INTERPLANETARY STUDY Final Report, 30 Jun. 1966–30 Aug. 1967

E. W. Greenstadt 30 Aug. 1967 66 p refs
(Contract NAS2-3665)
(NASA-CR-73125; TRW-06674-6005-R000) CSCL 03B

Graphs of flare index, proton flare observations, and supplementary figures are presented for a solar interplanetary study. Figures display a three-hour version of the index of flare activity over the six months of the second half of 1966. The data are compared with Explorer 33 field magnitude allowing a standard two-day sun–earth delay. It is concluded that solar wind velocity is the key to unlocking detailed information linking specific solar features to interplanetary magnetic effects; and it must be used to estimate the approximate time at which effective corotation ceases and solar wind expansion begins. S.P.

N67-37322*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.

ON THE ENERGY FLUXES OF LOW-ENERGY PROTONS AND POSITIVE IONS IN THE EARTH'S INNER RADIATION ZONE

L. A. Frank and R. L. Swisher Jun. 1967 15 p refs
(Contracts NAS5-2054; Nonr-1509(06); Grant NsG-233-62)
(NASA-CR-88886; Rept.-67-33; AD-656627)

A search for the large energy fluxes of low-energy protons or positive ions (500 eV approximately equal, or < E approximately

equal, or < 1 MeV) in the earths inner radiation zone as previously reported by Freeman via the analysis of the responses of CdS crystals borne on the earth-satellite Injun 1 is reported here utilizing recent measurements of energy fluxes of protons and positive ions within the energy range 100 eV to 4.2 MeV with earth-satellites OGO 3 and Injun 4. These recent measurements provide upper limits for these proton and positive-ion energy fluxes which are less by factors of approximately 10 to 100 when compared to the Injun 1 observations during 1961. The upper limits reported here strongly indicate that large energy fluxes of low-energy protons or positive ions, approximately 50 ergs/cm squared-sec-sr, are not a feature of the inner radiation zone. Author (TAB)

N67-37451# Rome Univ. (Italy). Inst. of Physics.
SYNOPTIC STUDY OF THE ATTENUATION COEFFICIENTS FOR THE COSMIC RAY NEUTRON MONITORS OF THE IGY NETWORK FROM 1957 TO 1965
F. Bachelet, E. Dyring, N. Iucci, and G. Villoresi 1967 32 p refs Submitted for publication
CFSTI: HC $3.00/MF $0.65

The solar cycle variation of the attenuation coefficient of the intensity recorded by the IGY neutron monitors is synoptically studied by regression analysis on daily data of 21 stations using 3-month periods from 1957 to 1965. A combined technique of reducing and filtering the data is applied before performing the least square analysis, in order to minimize the influence of primary and instrumental changes and to work towards optimal estimates. Values suitable for appropriate correction of the station data for pressure changes are generally found over the whole range of latitudes, altitudes, and times. However, a quantitative estimate of the typical peak-to-peak amplitude of the solar cycle change is reached only at high latitudes near sea level, where data from several stations under similar geophysical conditions are available and the effect is the largest. Here an average variation of about 4 percent is obtained, in agreement with an independent estimate of the effect. Author (ESRO)

N67-37459# Minnesota Univ., Minneapolis. Cosmic Ray Group.
THE ENERGY DEPENDENCE OF THE FRAGMENTATION PARAMETERS AND MEAN FREE PATHS OF COSMIC RAY NUCLEI WITH Z GREATER THAN 10^+
T. F. Cleghorn, P. S. Freier, and C. J. Waddington [1967] 14 p refs Presented at the 10th Cosmic Ray Conf., Calgary (Canada)
(Contract Nonr-710(60))
(CR-98; AD-656046)

The fragmentation parameters and interaction mean free paths for VH and H-type cosmic ray nuclei have been measured as functions of energy in nuclear emulsions. It is found that they are essentially independent of energy over the range from 100 MeV/n to 30 GeV/n. The mean free paths of the secondary nuclei produced in observed interactions have also been measured. With two major exceptions, the values of the mean free paths are found to be consistent with an overlap model for nuclear interactions. The value obtained for the secondary L-type nuclei appears to be significantly shorter than that expected from the model calculations while that for the primary VH nuclei appears to be significantly longer. Author (TAB)

N67-37629*# Oak Ridge National Lab., Tenn. Radiation Shielding Information Center.
ESTIMATES OF PRIMARY AND SECONDARY PARTICLE DOSES BEHIND ALUMINUM AND POLYETHYLENE SLABS DUE TO INCIDENT SOLAR-FLARE AND VAN ALLEN BELT PROTONS
W. Wayne Scott Jul. 1967 25 p refs
(NASA Order P-104(10))
(NASA-CR-88879; ORNL-RSIC-18) CFSTI: HC $3.00/MF $0.65
CSCL 20H

Primary proton and secondary particle doses (both physical and biological) behind aluminum and polyethylene slabs of varying thicknesses have been computed for normally incident solar-flare protons with spectra of characteristic rigidities (P_0 = 50, 60, 80, 100, 120, and 195 MV) and for the Freden–White spectrum of protons in the Van Allen belt. The computations were performed with a proton penetration code (CCC-64/LPSC) recently developed by the NASA Lewis Research Center. Author (NSA)

N67-37630 Joint Publications Research Service, Washington, D. C.
SOLAR WINDS AND INTERPLANETARY MAGNETIC FIELDS
E. R. Mustel 12 Sep. 1967 22 p refs Transl. into ENGLISH from Priroda (Moscow), no. 7, 1967 p 13–23
(JPRS-42567; TT-67-33195) CFSTI: $3.00

Interplanetary magnetic fields are discussed in terms of a continuously acting mechanism which sweeps the galactic magnetic field and the interstellar gas far to the outskirts of the solar system. Arguments in favor of the existence of the solar wind are offered, based on experimental data, and measurements made by the Lunik and Mariner space probes. Relationships between plasma velocity and the planetary geomagnetic activity index are drawn. A theory on the formation of the spiral field created by the solar wind in interplanetary space is examined in relation to the continuous outflow of gas from a certain specific small region of the sun. Measurements from IMP-1 and Mariner-4 are cited as verification. Also considered are ideas on a dynamic expanding corona, the influence of cosmic rays, and particle concentration and solar wind composition. M.G.J.

N67-37823# Massachusetts Inst. of Tech., Cambridge.
RADIO PROPAGATION EXPERIMENTS FOR MEASUREMENTS OF THE EXTENDED SOLAR CORONA
J. V. Harrington *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 185–224 refs (See N67-37816 22-25)

The fundamental physical effects experienced by a radio wave propagating through a plasma are reviewed. Effects such as differential time delay, Faraday rotation, and refraction are discussed as well as the fluctuations in these quantities produced by the inhomogeneities in the ionized medium. The application of radio propagation techniques to measurements on the extended solar corona and to planetary atmospheres is emphasized. Author (ESRO)

N67-37824# Yale Univ. Observatory, New Haven, Conn.
ULTRAVIOLET RADIATION FROM LATE-TYPE STARS
Ludwig Oster *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 267–289 refs (See N67-37816 22-25)

The existence and, possibly, the structure of outer atmospheres of stars in the neighborhood of the sun could be observed in the light of the hydrogen Lyman alpha line, λ 1216 Å, with rocket-borne experiments. It is shown that current theoretical ideas on the origin of the solar corona can be expanded to include a large class of late-type stars, and that chromospheres and coronas very similar to the solar case are expected. It is moreover shown that these atmospheres would produce a Lyman alpha line that is clearly within the range of detectability with available equipment. Author (ESRO)

N67-37848# National Bureau of Standards, Washington, D. C.
THE SOLAR SPECTRUM 2935 Å TO 8770 Å. SECOND REVISION OF ROWLAND'S PRELIMINARY TABLE OF SOLAR SPECTRUM WAVELENGTHS
Charlotte E. Moore, M. G. J. Minnaert (Utrecht Obs.), and J. Houtgast (Utrecht Obs.) Washington, GPO, Dec. 1966 378 p
(NBS-Monograph-61) GPO: $4.00

The present compendium contains corrected and supplementary material from the Utrecht Photometric Atlas. Measured equivalent widths from the Atlas replace the Rowland estimated line intensities. From these directly measured equivalent widths were derived reduced widths, which, if necessary, were corrected for disturbing influences. The intensity behavior of atomic lines in the spot spectrum as compared with the spectrum of the solar disk is indicated. Atomic lines present only in the spot spectrum are included. Revised identifications of the lines, as to chemical origin, are given for both atomic and molecular lines. For classified atomic lines the lower excitation potential and multiplet number are listed. For molecular lines the rotation branch and quantum number, and the vibration band are indicated. Tables include counts of lines of each spectrum recorded in the identification column, leading lines in the first and second spectra, and summaries of molecules and elements present in the sun. Sixty-three elements are recorded as present. The number of molecules identified in the sun totals 11. Author

N67-38032# Rice Univ., Houston, Tex. Dept. of Space Science.
PARTICLES AND FIELDS IN THE MAGNETOSPHERE
Brian J. O'Brien [1967] 22 p refs Presented at the Natl. Acad. of Sci. Ann. Meeting, Washington, D.C., 26 Apr. 1967

An overview is presented on the state-of-the-art knowledge of magnetospheric particles and fields. It is pointed out that over one billion relevant measurements have been made in space by some 700 instruments on over 100 spacecraft, and that worthwhile scientific results have been attained by international coordinated programs such as IQSY and IGY. The concepts of the 30s are compared with the changing views of the 50s and 60s, with particular reference to auroras, the magnetosphere as a plasma laboratory, Van Allen radiation, the plasmapause, and magnetic fields. Figures depict particle fluxes in the near-earth environment and show the wide variability in fluxes of particles of the solar wind, thermalized solar wind, auroras, and Van Allen radiation. M.G.J.

N67-38038*# Volt Technical Corp., Washington, D. C.
RELATIONSHIP BETWEEN THE RADIOEMISSION FLUX FROM LOCAL SOURCES IN THE SUN WITH THE STRUCTURE OF THE OPTICALLY OBSERVED ACTIVE REGIONS [O SVYAZI POTOKA RADIOIZLUCHENIYA LOKAL NYKH ISTOCHNIKOV NA SOLNTSE SO STROYENIYEM AKTIVNYKH OBLASTEY NABLYUDAYEMYKH OPTICHESKI]
A. R. Abbasov 9 Oct. 1967 5 p refs Transl. into ENGLISH from Dokl. Akad Nauk SSSR, Ser. Astron., v. 174, no. 3, 1967 p 538–540
(Contract NAS5-12487)
(NASA-CR-88889; ST-SP-RA-10653) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The relationship between radioemission flux from solar local sources with the structure of active regions observed optically is discussed using results of statistical processing of radio astronomical data. Comments regarding proton burst forecasts are given. Author

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N67-38701* National Aeronautics and Space Administration, Washington, D. C.
REPRESENTATION OF THE GENERAL SOLUTION OF THE THREE-BODY PROBLEM BY CONVERGENT SERIES [O PREDSTAVLENII OBSHCHEGO RESHENIYA ZADACHI TREKH TEL SKHODYASHCHIMISYA RYADAMI]
G. A. Merman Dec. 1966 25 p refs Transl. into ENGLISH from Byul. Inst. Teor. Astron. (USSR), v. 6, no. 10, 1958 p 713–731
(NASA-TT-F-10477) CSCL 03C

The possibility is shown of representing the general solution of the three-body problem by convergent series differing from Sundman series, on the basis of certain estimates deduced from the general existence and continuity theorems for the solutions of ordinary differential equations with the use of Merman's work. The sequence of polynomials $P_n(\theta)$ is derived from differential equations by Cauchy integration. Author

N67-38711* Arizona Univ., Tucson.
COMMUNICATIONS OF THE LUNAR AND PLANETARY LABORATORY NUMBER 92, VOLUME 6, PART 2
H. L. Johnson, R. I. Mitchell, and A. S. Latham 14 Jun. 1967 69 p refs
(Contracts NSR-03-002-048; NASr-218; Grant NsG-733)
(NASA-CR-88382) CSCL 03A

Eight-color photometry of 985 stars north of −20° declination is presented. The medium–narrow filters are similar to those of Borgman, and our data should be capable of similar interpretations. An absolute calibration of the new photometry was derived. The data given should be regarded as defining the shorter-wavelength portion of a 13-color medium-narrow-band photometric system, extending from 3300 Å in the ultraviolet to 11,000 Å in the infrared. Author

N67-38772*# IIT Research Inst., Chicago, Ill. Technology Center.
COMPOSITIONAL ANALYSIS OF LUNAR AND PLANETARY SURFACES USING NEUTRON CAPTURE GAMMA RAYS Annual Report, May 1, 1966–Jun. 30, 1967
John H. Reed 1 Jul. 1967 102 p refs
(Contract NASr-65(18))
(NASA-CR-88485; IITRI-A6155-5) CSCL 03B

Computer calculations were performed using the one-dimensional DTK neutron transport computer code assuming an isotropic 14-MeV neutron source on the surface of a large sample. The results predicted that the flux of thermal neutrons increases with depth and reaches a maximum at about 90 gm/cm^2 below the surface of the sample. If a paraffin reflector a few centimeters in thickness is placed above the 14-MeV neutron source, the thermal flux at the surface is greatly increased, and has its maximum value there. These predictions were verified experimentally by measuring the thermal flux distribution in a large sand sample both with and without a reflector above the 14-MeV neutron source. A parametric study was made to determine the effects of variables on the sensitivity of the capture gamma ray technique. Results established the feasibility of applying the technique to the analysis of semi-infinite samples. Author

N67-38787# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
ANALYSIS OF TIME-DELAY MAGNETIC DAMPING OF SPACECRAFT LIBRATIONS IN NEAR-SYNCHRONOUS EQUATORIAL ORBITS
D. L. Mackison Jun. 1967 51 p refs
(Contract NOw-62-0604-c)
(TG-916; AD-655425)

Time-lag magnetic damping provides a method of using the earths magnetic field for rapid libration damping of satellites when the field strength is insufficient to dissipate energy with

magnetic hysteresis material. This consists of generating a spacecraft-fixed magnetic dipole, initially parallel to the earths magnetic field, and holding it constant as the spacecraft librates. When the magnet is turned off, a portion of the satellites angular momentum has been transferred to the earths magnetic field. A mathematical model is developed relating the dipole moment, the dipole holding time, and the initial attitude to the energy dissipation rate. Comparisons are made between the results predicted analytically by the damping model and those obtained by numerical integration of the differential equations of attitude motion.
Author (TAB)

N67-36809# Liege Univ. (Belgium). Dept. of Astrophysics.
RESEARCH ON RELATIONS BETWEEN COMETARY, SOLAR AND UPPER ATMOSPHERIC PROCESSES Final Scientific Report, 1 Apr. 1962–31 Mar. 1967
Pol Swings 10 Apr. 1967 127 p
(Contract AF 61(052)-587)
(AFCRL-67-0303; AD-655385)

Laboratory work has been carried on: the time resolution of spectra; the spectra of several molecules of astronomical or geophysical interest; various photometric and spectrographic instruments; the study of photomultipliers; the study of diffraction gratings. The physical mechanisms in comets have been further discussed. Other instrumental, observational and theoretical programs of cometary, solar and stellar investigations have been started. Investigations related to space experiments are mainly concerned with the far ultraviolet spectra of stars, planets, comets and aurorae, and with artificial comets. New types of spectrographs have been designed and constructed in preparation of space experiments.
Author (TAB)

N67-36810*# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
THE SEPARATE COMPUTATION OF ARCS FOR OPTIMAL FLIGHT PATHS WITH STATE VARIABLE INEQUALITY CONSTRAINTS Interim Technical Report
Jason L. Speyer, Raman K. Mehra, and Arthur E. Bryson, Jr.
May 1967 33 p refs
(Grant NGR-22-007-068; Contract Nonr-1866(16))
(NASA-CR-88559; TR-526; AD-656394) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Separate computation of arcs is possible for a large class of optimization problems with state variable inequality constraints. Surprisingly, this class (to the best of the authors knowledge) includes all physical problems which have been solved analytically or numerically to date. Typically these problems have only one constrained arc. Even in more complex problems, separation of arcs can be used to search for additional constrained arcs. As an important example, a maximum range trajectory for a glider entering the Earths atmosphere at a supercircular velocity is determined, subject to a maximum altitude constraint after initial pull-up. It is shown that the optimal path can be divided into three arcs, which may be determined separately with no approximations. The three arcs are (1) the initial arc, beginning at specified initial condition and ending at the entry point onto the altitude constraint; (2) the arc lying on the altitude constraint; and (3) the terminal arc, beginning at the exit point of the altitude constraint and ending at some specified terminal altitude. The conjugate gradient method, a first order optimization scheme is shown to converge very rapidly to the individual unconstrained optimal arcs. Using this optimization scheme and taking advantage of the separation of arcs an investigation revealed that two locally optimum paths exist. The range of one exceeds the range of the other by about 250 nautical miles (about 8%) for the re-entry vehicle used here (maximum lift-to-drag ratio is .9).
Author (TAB)

N67-36831# RAND Corp., Santa Monica, Calif.
ORBITAL BASING: KEY TO LOW COST SPACE OPERATIONS?
G. A. Sears Jul. 1967 25 p refs
(P-3570; AD-655342)

A comparison is made of some of the operational and cost-influencing characteristics of low-orbit space operations conducted from a manned orbital base and from an earth base. The earth-based mode of operation is that employed today, whereby expendable spacecraft are placed in mission orbits with expendable launch vehicles. In the orbital-basing concept the spacecraft are based at a manned space station, are injected into their mission orbits as required, and subsequently rendevous with the space station for rejuvenation and reuse. Reuse has long been considered the key to lowering the very high cost of space operations; however, most reuse concepts studied in depth have involved recovery to earth of launch vehicles and/or spacecraft. The reasons why development of reusable systems has not been initiated are many, prominent among which are these: (1) Very significant weight penalties are associated with recovery gear, particularly orbital recovery gear; (2) refurbishment costs and useful life of recovered vehicles are difficult to appraise; and (3) traffic rates are not foreseen which are adequate to amortize R and D costs of billions of dollars over a reasonable time period. These problems are all associated with recovery, however, and can be avoided by reuse of equipment on orbit.
Author (TAB)

N67-36932*# National Engineering Science Co., Pasadena, Calif.
FEASIBILITY ANALYSIS OF PARACHUTE ENTRY FOR MARS LANDER
E. Mayer 19 May 1967 57 p refs Prepared for JPL
(Contract NAS7-100)
(NASA-CR-88498; S-424) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The feasibility of a parachute entry system for a Mars lander was studied in accordance with a work statement appended to this report. The principal restrictions in the work statement specify the range of ballistic coefficients $10^{-1} \geq \beta$ slugs/ft^2 $\geq 10^{-3}$; the weight of the deceleration system limited to not more than payload weight W_p=50 lb; and entry velocities in the range $6 \leq V_3$ kft/sec ≤ 16. Furthermore, consideration of a high-temperature high-strength plastic (Nomex) undergoing "laminar" peak heating is specified in the work statement. With the above restrictions, it was found that feasibility limit conditions are reached for entry velocity V_e=6.3 kft/sec in a parachute system with ballistic coefficient $\beta \cong 2\times10^{-2}$ slugs/ft^2. At this feasibility limit most of the system weight is needed to provide a massive blunted leading edge for canopy to alleviate the laminar heat transfer, and thereby prevent the development of temperature in excess of the permissible maximum for Nomex, $T_{max} \cong 500°F$, at the leading edge. Results further showed that greater entry speeds are feasible if the restriction to laminar peak heat transfer is relaxed and design configurations with sharp leading or windward elements are taken into consideration. The low weight requirements of the design examples summarized suggest that, by utilizing high temperature, high strength metals for parachutes having the sharp windward edge dimensions to assure peak heat load in free molecule flow, the feasibility entry velocities may be significantly increased without exceeding the system weight limitation of 50 lb.
Author

N67-37009*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RESEARCH AND ADVANCED DEVELOPMENT PUBLICATIONS, FISCAL YEAR 1966
30 Jun. 1967 81 p refs
(Contract NAS7-100)
(NASA-CR-88619; JPL-R; AD-701-2) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A bibliography of publications relating to bioscience, physical space science, electronics, spacecraft and capsule aeromechanical engineering, fluids, space power, and chemical and electric propulsion, is presented. The material covers planetary and interplanetary missions; planetary atmospheres; interplanetary fields and particles; spacecraft guidance, control, tracking, and communications systems; and liquid and solid chemical propulsion systems. Other relevant activities are also listed. L.S.

N67-37019*# Houston Univ., Tex.
STUDY OF SOLAR FLARE PARTICLES EVENTS AND RELATED SOLAR PHYSICS
[1967] 3 p
(Grant NGR-55-005-041)
(NASA-CR-88717) CFSTI: HC $3.00/MF $0.65 CSCL 03A

The interaction of interstellar neutral hydrogen with the solar wind is discussed, and it is reported that a solution for the density of such neutral hydrogen in the vicinity of the sun was obtained. The geophysical effects of the interstellar neutral hydrogen were outlined by calculating the flux of energetic neutral hydrogen expected at the earth's orbit due to charge–exchange collisions between solar wind protons and the interstellar hydrogen. Brief mention is made of projects pertaining to sunspot evolution, solar spectrography, and the H-alpha solar patrol. M.G.J.

N67-37051# Texas Technological Coll., Lubbock. Dept. of Chemistry.
SPECTRAL STUDIES OF MATERIALS POSSIBLY PRESENT ON THE MARTIAN SURFACE Final Report No. 2, 1 Feb. 1966–31 Jan. 1967
Arthur L. Draper and Joe A. Adamcik 1 Jun. 1967 13 p refs
(Contract Nonr-(G)-00010-66)
(AD-655257)

Comparing the reflectance spectra of synthetic mixtures with the observed spectrum of Mars has been continued to develop mixtures congruous with the Martian soil so that limits may be set on its composition. Mixtures containing various amounts of the iron oxides goethite and hematite precipitated on finely ground quartz and kaolin show the features of the Martian spectrum after the addition of dark materials such as magnetite or hornblende. The effect of temperature, particle size and iron oxide content on the spectra of the mixture components was examined. At low temperatures (-190C) spectral features are detectable. A synthetic material of particle size less than 37 microns is required to give a proper match to the Martian spectrum. The spectra of mixtures containing in the vicinity of 10% iron oxides do not seem to be highly sensitive to the total iron oxide content. Author (TAB)

N67-37082*# Arizona Univ., Phoenix.
COMMUNICATIONS OF THE LUNAR AND PLANETARY LABORATORY, NUMBERS 79–91, VOLUME 6, PART 1
1967 87 p refs
(Grant NsG-161)
(NASA-CR-88749) CSCL 03B

Reports on laboratory experiments and astronomical observations are presented. Lunar crater counts and lunar cratering are discussed, and the Leonid meteor shower of November 17, 1966, is described. Photometric data of the eclipse reappearances of satellites Jupiter I, II, and III, and of T Tauri stars are given. Observations of plane interstellar polarization and the wavelength dependence of the interstellar polarization are reviewed. The development and preparation of solid organic filters using a polymethyl siloxane resin are outlined. Laboratory experiments for detecting small amounts of various gases that may occur in planetary atmospheres are mentioned. N.E.N.

N67-37171# Naval Weapons Lab., Dahlgren, Va.
ON APPROXIMATING A PERIODIC ATMOSPHERIC DRAG FUNCTION FOR SATELLITES BY A PIECEWISE CONSTANT FUNCTION
Bernd Zondek [1967] 17 p
(NWL-2090; AD-656086)

A satellite is affected by periodic drag fluctuations. We approximate the periodic drag by a step function. We calculate the standard deviation in the satellites coordinates due to this approximation. The results permit us to estimate the time over which we may keep the drag coefficient constant so as to achieve any desired degree of signal reduction. We confine ourselves to circular orbits. Numerical results are given for a 90 minute satellite and a drag to gravity ratio of 2 x 10 to the -8th power. Author (TAB)

N67-37243# RAND Corp., Santa Monica, Calif.
THE TWILIGHT ATMOSPHERE OF VENUS
G. F. Schilling and R. C. Moore Jul. 1967 97 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5386-PR; AD-656307)

An investigation of the discrepancies between the theoretically predicted and the actually observed shape and periodic appearance of Venus. Current astronomical methods of observation of the twilight sky of Venus are investigated by combining a rigorous celestial geometry with a determination of the physical effects exerted by the relative luminances of the atmospheres of Venus and the Earth. Analysis shows that the discrepancy between the expected and observed times of dichotomy corresponds to a range in position angle from about 92 to 98 degrees, which implies a minimum height of the effectively scattering atmosphere from 13 to 23 km. There are indications that the true height may be several tens of kilometers. TAB

N67-37303*# Boeing Scientific Research Labs., Seattle, Wash.
ISOTHERMAL AND ISOPHOTIC ATLAS OF THE MOON: CONTOURS THROUGH A LUNATION
J. M. Saari and R. W. Shorthill Washington, NASA, Sep. 1967 192 p refs
(Contract NASw-982)
(NASA-CR-855) CFSTI: HC $3.00/MF $0.65 CSCL 03A

Infrared (10–12 microns) and photometric (0.45 microns) measurements were made with a rapid-scan system over the illuminated lunar disk through a lunation. Isothermal and isophotic contour charts are presented for 23 phase angles, with location information being provided by overlaid standard orthographic grids. The observations were made with a resolution of 8" and 10" arc allowing correlation with topographic features. Rougier's measurements of the integral brightness of the moon with phase angle were used to provide the photometric calibration. In most cases, the isotherms were calibrated with reference to a calculated value of the subsolar point, which included corrections for the local albedo, the distance to the sun, and directional effects. Otherwise, the calibration was done taking into account atmospheric losses and using a black body calibration of the detector. Author

N67-37307# France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-Sous-Bagneux.
ERROR ANALYSIS IN CLOCK TRAJECTOGRAPHY [ANALYSE DES ERREURS EN TRAJECTOGRAPHIE A L'HORLOGE]
Robert Galerne and Jacques Zakheim 18 May 1967 28 p refs
In FRENCH; ENGLISH summary
(TN-111(1967))

In the first part of this note, the errors on position in clock trajectory are determined as a function of the elementary errors of measurement. The general characteristics of clock trajectography

are defined and it is shown that it can improve the radial precision for long range vehicles. A general investigation on the precision of restitution of the velocity vector shows the effect of the errors made on position. In the second part, the method suggested is applied to y typical case. The main causes of errors are analyzed and their effect on the precision of position is examined. Author

N67-37328*# TRW Systems, Redondo Beach, Calif.
SITE ACCESSIBILITY ANALYSIS FOR ADVANCED LUNAR MISSIONS VOL. I: SUMMARY. Final Report
H. Patapoff 30 Jun. 1967 102 p refs
(Contract NAS9-4810; Project Apollo)
(NASA-CR-65728; TRW-05952-H223-RO-00, Vol. I; TRW-67-FMT-521, Vol. I) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A simplified and relatively rapid mission analysis procedure for determining approximate lunar areas of accessibility for mission planning purposes is presented. The procedure consists of three basic steps: 1) the determination of the various geometrical constraints upon site accessibility, 2) the determination of the ΔV constraints or requirements upon accessibility, and 3) the graphical procedure which consists of the manipulation or interpretation of the results of the first two steps to provide the answer or data for the specific mission under consideration. A discussion of these basic steps is given along with the detailed procedure for two example cases. The translunar and transearth velocity data presented and used in the graphical procedure, represent optimized two-impulse transfers to and from the moon. These transfers provide considerable savings in SM fuel when compared with single impulse transfers presently planned for the Apollo missions. The mission analysis procedure is independent of the mode of orbit transfer and its only requirement is that the velocity data be in the proper format. R.N.A.

N67-37330*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
SATELLITE ALTIMETRY AND ORBIT DETERMINATION
Charles A. Lundquist 18 Aug. 1967 19 p refs
(Contract NSR-09-015-054)
(NASA-CR-88710; SAO Special Rept.-248) CSCL 22C

The technological problems associated with altimetry from a satellite are the subject of wide investigation in the United States. Therefore, it is reasonable to assume that accurate altitudes measured from satellites will eventually be available, and it is prudent to ask now what are the interfaces between altitude measurements and satellite-orbit determination practices. From one point of view, accurate altitude data may generate accuracy requirements that must be met by orbit determination procedures. From another point of view, the altitudes themselves may be used as tracking data in orbit determination. If the altitude of a satellite above the ocean surface is obtained, this may be viewed as a measured relationship between a point on an equipotential surface of the geopotential and a satellite position determined by the equations of motion derived from the geopotential. These various interfaces can be explored in the context of the procedures used at the Smithsonian Astrophysical Observatory for orbit determination and geophysical research. Author

N67-37383*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
THEORETICAL RESEARCH ON STELLAR ATMOSPHERES
Charles A. Whitney 1 Aug. 1967 42 p refs
(Grant NgR-22-024-001; Contract AF 19(628)-3877; Grants NSF GP-4318; NSF GP-940)
(NASA-CR-88709; SAO Special Rept.-247) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A brief sketch of the development of the theory of stellar atmospheres since 1920 is followed by a discussion of problems that may be central to this theory during the next five years. An annotated bibliography is provided of theoretical work performed at Harvard College Observatory and Smithsonian Astrophysical Observatory during the decade 1957–1967. Author

N67-37390# Chrysler Corp., Huntsville, Ala. Space Div.
ORBITAL TRANSFER AND RENDEZVOUS: A BIBLIOGRAPHY
Gary P. Herring 30 May 1967 31 p refs
(HSM-N42-67)

The bibliography is presented to make available to the scientific community an essentially complete listing of available research publications in the area of impulsive transfer and rendezvous. Several papers which are only indirectly related to the impulsive problem have been included. Author

N67-37398* Philco Corp., Palo Alto, Calif. Space and Re-entry Systems Div.
MARS–VENUS–EARTH SWINGBY TRAJECTORIES, 1971–1999 HANDBOOK
Paul J. Rohde 15 Apr. 1967 111 p refs
(Contract NAS8-20358)
(NASA-CR-88761; SRS-TR-147) CSCL 22C

The handbook presents Mars return trajectories that utilize Venus as an intermediate body. The swingby return trajectory analysis is restricted to specific times of interest. Low energy direct outbound trajectories to Mars exist for each Earth–Mars opposition. The analysis reported here investigates the availability of swingby return trajectories to meet these outbound trajectories with short stay times at Mars. The date of Mars is varied ± 50 days from the arrival date of the minimum energy outbound. The return flight time is varied from 200 days to 400 days. The analysis of this type of time region is done with a 10 day by 10 day grid for each opposition from 1971 to 1999 inclusive. The three body program and planetary ephemeris used in the computation of the trajectory data are described and the trajectory data are presented in tabular form. Bar graphs illustrate the hyperbolic excess speeds required for direct outbound and swingby return trajectories for each of the oppositions. Author

N67-37464*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A METHOD OF SOFT TETHER STATIONKEEPING
B. S. Perrine, Jr. 31 Jul. 1967 46 p refs
(NASA-TM-X-53643) CFSTI: HC $3.00/MF $0.65 CSCL 22A

This report considers the motion of one spacecraft in a near-circular orbit which is fastened to another with a flexible tether line. The equations of motion are obtained through a closed form solution to the approximate differential equation. A method is devised by which pulls can be made on the tether in a repeatable sequence so that the two spacecraft will remain in the vicinity of one another when there are differential drag forces acting on them. This method is then applied to the case of the Lunar Module/Apollo Telescope Mount (LM/ATM) tethered to an S-IVB Orbital Workshop (OWS). Author

N67-37577*# Litton Systems, Inc., Minneapolis, Minn. Applied Science Div.
INVESTIGATION OF SPUTTERING EFFECTS ON THE MOON'S SURFACE Final Report, 25 Apr. 1963–2 Jun. 1967
G. K. Wehner and C. E. Kenknight 1 Jun. 1967 51 p refs
(Contract NASw-751)
(NASA-CR-88738; Rept.-3107) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Research from 1963 to 1967 on effects of solar-wind bombardment of the lunar surface is summarized. Erosion due to

sputtering by the solar wind is not estimated to be 2 cm in a 4.5×10^9 yr history at current rates. Studies on lunar optical properties in comparison with ion-bombarded powder samples imply a low density surface of insulating (non-metallic) particles mostly less than 0.1 mm in diameter. Surveyor photographs are consistent with formation of a powder layer of at least meter thickness by meteoritic bombardment. Albedo contrast between rocks and powder in that layer is consistent with darkening of the powder by the solar wind or some other external agent or with marked differences in two rock sources contributing to that layer. Cementation of the lunar surface powder, now confirmed by Surveyor data, was suggested by cementation of ion-bombarded powder samples in simulation experiments. Author

N67-37586* Arizona Univ., Phoenix.
COMMUNICATIONS OF THE LUNAR AND PLANETARY LABORATORY, NUMBER 92, VOLUME 6, PART 2
1967 71 p refs
(Grants NSR-03-002-048; NsG-733; NASR-218)
(NASA-CR-88750) CSCL 03B

Absolute calibration, scientific instrumentation, and tabular data on photometric observations of 985 stars north of −20° declination are presented. Graphs depict the normalized response function for various filters used in the eight-color photometry data. The data presented should be regarded as defining the shorter-wavelength portion of a 13-color medium-narrow-band photometric system, extending from 3300 Å in the ultraviolet to 11,000 Å in the infrared. R.U.

N67-37651*# Geological Survey, Washington, D. C.
ASTROGEOLOGIC STUDIES. PART D: SPACE FLIGHT INVESTIGATIONS Annual Progress Report, 1 Jul. 1965–1 Jul. 1966
Dec. 1966 93 p refs
(NASA Order R-66)
(NASA-CR-88532; APR-7) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Included are reports on geologic analysis and mapping from Ranger photographs, research on methods of Ranger photogrammetry, an analysis of small lunar craters by comparison with experimentally produced impact and explosion craters, and a sample of the preflight geologic reports prepared for the sites photographed by Lunar Orbiter I. Author

N67-37656*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
DESIGN OF A SATELLITE EXPERIMENT FOR ATMOSPHERIC DENSITY AND NEAR-FREE-MOLECULE-FLOW AERODYNAMICS
Louisa S. Lam, Geraldine M. Mendes, and Charles A. Lundquist 5 Jun. 1967 46 p refs
(Grant NSG-87-60)
(NASA-CR-88868; SAO-Special Rept.-241) CPSTI: HC $3.00/MF $0.65 CSCL 22A

The atmospheric drag on a satellite is conveniently determined from the rate of change of the orbital period dP/dt. This procedure can be extended to the near-free-molecule-flow regime, in which the drag coefficient of a sphere is expressed by $C_D = C_{Dfm} - F(S_b, S_\infty)/K$, where C_{Dfm} is the free-molecule-flow coefficient, and $F(S_b, S_\infty)$ is a function of the molecular speed ratios for gas diffusely emitted from the body surface and for the free stream. For a practical experiment, particular orbit characteristics and satellite parameters must be selected to match available launch-vehicle performance. Two concrete examples are discussed. The first assumes the performance of the Scout vehicle. This example shows that a reasonable experiment seems possible even for this modest vehicle. The second example adopts parameters that may be typical of a secondary mission on a Saturn class vehicle. Author

N67-37666* North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.
AN ANALYSIS OF TWO-IMPULSE ORBITAL TRANSFER
Gentry Lee 1 Jul. 1963 63 p refs
(Contract NAS8-5211)
(NASA-CR-88480; SID-63-741) CSCL 22C

Analytical investigations of two-impulse transfers between elliptical orbits, using vector analysis and other mathematical techniques, have yielded pertinent, heretofore unknown facts about an orbital transfer function. One particular mode of analysis, the Bell-Arenstorf technique, helped show not only that the minimum velocity increment solution between two points on elliptical orbits could be along a hyperbola, but also that there could be two relative minima in this impulse function. Particular examples of both these phenomena are given. Inclined elliptical orbits as well as coplanar elliptical orbits are discussed. An eight-order polynomial expression, the real roots of which may refer to extrema in the impulse function, is determined. Two test functions are determined to define regions in which all extrema must lie and to identify those roots that are extraneous. These new analytical findings have been incorporated into an earlier computer contour mapping program that locates the optimum transfer between elliptical orbits. Author

N67-37718# European Space Data Centre, Darmstadt (West Germany).
DETERMINATION OF THE TOPOCENTRIC HORIZONTAL COORDINATES OF CELESTRIAL BODIES FROM GEOCENTRIC RIGHT ASCENSION, DECLINATION AND PARALLAX
H. G. Walter Paris, ESRO, Jan. 1967 15 p refs
(ESRO-SN-1) CFSTI: HC $3.00/MF $0.65

A scheme is laid down for the determination of the position of a celestial body with respect to the topocentric horizontal coordinate system. The geocentric right ascension and declination are assumed to be known and the topocentric coordinates are calculated from these quantities taking into account the oblate shape of the earth. The method is particularly applicable to the moon, the sun and the stars, but can also be extended to artificial satellites. Author (ESRO)

N67-37717# Liege Univ. (Belgium). Institut d'Astrophysique.
REPORT ON THE PRESENT STATE OF PREPARATION FOR THE NEXT EXPERIMENTS OF THE PROGRAM "ARTIFICIAL COMETS"
B. Rosen [1967] 20 p ref
CFSTI: HC $3.00/MF $0.65

The first two series of artificial comets were launched in 1964 and 1966 with the aim to test the feasibility of rocket experiments connected with cometary physics and to determine the best observational conditions and the needed equipment. This feasibility has been definitely proved and the results were sufficiently encouraging to consider a large scale attempt to solve some more specific and fundamental cometary problems, the most important one being the determination of those cometary compounds which are responsible for production of observed cometary species. This paper gives the international collaboration, the general astrophysical considerations, as well as the program of laboratory work preparatory to the next launching of the same series (Skylark rockets) scheduled for spring 1969. Author (ESRO)

N67-37763*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
RELAXATION OF A ONE-DIMENSIONAL SELF-GRAVITATING GAS
Myron Lecar and Leon Cohen *In* NASA, Washington Symp. on Computer simulation of Plasma and Many-body Probl. 1967 p 299–308 refs (See N67-37737 22-25)

The one-dimensional model, which describes the motions of the stars in the solar neighborhood in a direction perpendicular to the plane of the galaxy, was investigated to study the relaxation of a self-gravitating gas. The form that f(x,v,t) takes due to collective interactions was examined, and an experiment, starting with an asymmetric distribution, was undertaken to see if it became symmetric. It was found that the system settled down to a function of the energy, contrary to current statistical theory. N.E.N.

N67-37754*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
RELAXATION OF A TWO-COMPONENT SELF-GRAVITATING GAS
Leon Cohen and Myron Lecar *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-body Probl. 1967 p 309–314 (See N67-37737 22-25)

An experiment is briefly described to determine if the distribution function evolves independently of the mass and if there is a lack of equipartition of energy among the lighter and heavier masses. A system of 500 particles of unit mass and 500 of mass 10 was integrated for about 20 dynamical periods, and the data are graphed. It was found that the steady state approached is independent of mass and that the equipartition of energy is not obeyed. N.E.N.

N67-37758*# Institut d'Astrophysique, Paris (France).
THE N-BODY GRAVITATIONAL PROBLEM AND THE SIMULATION OF GALACTIC CLUSTERS
A. Hayli *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-Body Probl. 1967 p 315–321 refs (See N67-37737 22-25)

The results obtained by different authors in the integration of the n-body problem both in the absence and in the presence of an external field are reviewed. The problem of simulating galactic clusters is discussed and the equations of motion and the first integrals are presented. The principle of a new method for integrating the problem is introduced. Finally some results are given obtained for clusters with 25, 31, 32 and 48 stars with and without a galactic field. Author

N67-37760*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ONE-DIMENSIONAL AND TWO-DIMENSIONAL MODELS TO STUDY THE EVOLUTION OF STELLAR SYSTEMS
Frank Hohl *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-Body Probl. 1967 p 323–336 refs (See N67-37737 22-25)

A variational principle was applied to one-dimensional stellar systems to show that stationary distribution functions which are always decreasing in going outward from the center of the system are stable. Other stationary distributions may be unstable as is illustrated by means of computer experiments. Numerical experiments with a simple two-dimensional rod model show that the spiral structure and other filamentary structure of galaxies may result from purely gravitational effects. Author

N67-37767*# Stanford Univ., Calif. Inst. for Plasma Research.
GRAVITATIONAL EXPERIMENTS WITH A CYLINDRICAL GALAXY
R. W. Hockney *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-Body Probl. 1967 p 337–347 ref Submitted for publication (See N67-37737 22-25)

A computer model is used to perform gravitational experiments on the evolution of a two-dimensional galaxy. The motion of 2000 rod-stars is computed step-wise in time as they move according to Newton's law of motion in their mutual gravitational field. The effect of collisions between stars may be estimated. In the cases described, the collision time equals the rotation time of the galaxy. Phenomena over a time span between 1 and 10 galactic rotations are studied, and for these intervals the computer model does represent a collisionless star system, and is thus a good model of a real galaxy. Author

N67-37768*# Institut d'Astrophysique, Paris (France).
COLLECTIVE MOTIONS IN A SPHERICAL STAR CLUSTER
Michel Henon *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-Body Probl. 1967 p 349–364 refs (See N67-37737 22-25)

The first phase, or mixing phase, of the evolution of a stellar system is considered. The associated time scale is taken as the crossing time, so that the effect of encounters can be neglected. The formation of the star cluster with spherical symmetry is discussed. Equations are presented which show that the variation in time of three quantities (the distance to the center, and the radial and tangential components of the velocity) is determined if the initial values of the quantities are known. Stars with the same values for the three quantities are collected to form a shell, and the cluster is composed of concentric shells whose radii change with time. Experimental computations were carried out, and include the following cases: a homogeneous spherical cluster with a Maxwellian distribution of the velocities for the initial state; all shells with the same angular momentum; a reflecting sphere around the cluster; and shells with small radial velocities. The results are graphed, and indicate that the general theory of collective motions in a gravitational system may be complex. N.E.N.

N67-37761*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
METHODOLOGY IN THE N-BODY PROBLEM: LAGRANGE VERSUS EULER APPROACH
Oscar Buneman (Stanford Univ.), John M. Dawson (Princeton Univ.), Marc R. Feix, Rodger W. Hockney (Stanford Univ.), and Craig G. Smith *In* NASA, Washington Symp. on Computer Simulation of Plasma and Many-Body Probl. 1967 p 407–416 ref (See N67-37737 22-25)

A panel discussion is presented on the n-bodied problem and computer experiments. The advantages of using the computer for complex problems are pointed out, as well as the pitfalls involved in computer methods. The Vlasov, Lagrange, and Euler equations are discussed, along with the water bag model which is a compromise between the Lagrange and Euler approaches. Different methods of solving different types of problems are indicated. N.E.N.

N67-37787*# Harvard Coll. Observatory, Cambridge, Mass.
ABSORPTION SPECTRUM OF IRON IN THE VACUUM ULTRAVIOLET 2950–1588 Å
Dorothy W. Weeks and Edwina A. Simpson May 1967 52 p refs
(Grant NsG-438)
(NASA-CR-88742; SR-19) CFSTI: HC $3.00/MF $0.65 CSCL 03B

An index is presented of the plates measured to determine the absorption spectrum of iron in vacuum ultraviolet from 2950 to 1588 Å, and the iron compound excited by the shock is given for each plate. An Eagle-type vacuum spectrograph with a 3-meter concave grating was used; and the plates had an average dispersion of approximately 2.76 Å/mm. This dispersion was not constant, but varied linearly. The lines measured on the indexed plates are tabulated; and the wavelengths in vacuum below 2000 Å and in air above 2000 Å are given each case, along with the corresponding emission line reported in the literature. Differences between the newly determined and previously reported data are

tabulated. Somewhat more than one-third of the lines in the region between 2950 to 2084 Å had a difference equal to or less than 0.003 Å, which means a variation in measurement of 1 micron; and a little less than one-third of the lines in this region had a difference greater than 0.01 Å. The other two regions, from 2084 to 1855 Å and from 1855 to 1751 Å, differed slightly from the first region. In the first region, only 15 lines or less than 2% had a difference greater than 0.05 Å, while the other two regions had no such lines. M.W.R.

N67-37801*# California Univ., Berkeley. Space Science Lab.
RESPONSE OF THE GEOMAGNETIC ACTIVITY INDEX Kp TO THE INTERPLANETARY MAGNETIC FIELD
Kenneth H. Schatten and John M. Wilcox 28 Mar. 1967 29 p refs *Its* Ser. 8, Issue 22
(Grant NsG-243; Contract Nonr-3656(26))
(NASA-CR-88888; AD-652380) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Interplanetary magnetic field observations with IMP-3 during eight solar rotations in the latter half of 1965 have been compared with the 3-hour Kp index. The results are consistent with those obtained with IMP-1 from three solar rotations in winter of 1963-4, indicating a stability in the response of geomagnetic activity during these years near solar activity minimum. The larger data sample in the present investigation reduces the probable error and delineates some interesting results. The average value of Kp decreases as the angle between the interplanetary field and the ecliptic changes from south to north. This is consistent with the reconnection of interplanetary and geomagnetic field lines as suggested by Dungey. As a function of interplanetary field magnitude B, the average value of the index ap is more linear than Kp, as might be expected. The relation can be described by ap = (1.5 plus or minus 0.1) B + 0.7 plus or minus 0.5. In the time interval covered by these observations the average value of Kp is consistently higher in sectors with interplanetary field directed away from the sun than in sectors with field directed toward the sun. Author (TAB)

N67-37805*# TRW Systems, Redondo Beach, Calif.
PERFORMANCE ANALYSIS OF THE GENERAL TWO-BURN GUIDANCE EQUATIONS
R. C. Eberhard 18 Nov. 1965 56 p refs
(Contract NAS3-3231)
(NASA-CR-72311; TRW-4516-6002-TO-000) CSCL 22C

A performance analysis was made of the two-burn guidance equations for injecting the Atlas/Centaur vehicle into a satisfactory lunar trajectory. Major sources of performance degradation in the guidance equations are identified, and perturbations to the mean vehicle characteristics which have the greatest effect on guidance system accuracy are determined. The first step in the analysis plan was the development of the digital simulations of the vehicle dynamics and the guidance equations. The second step was to "fly" the guidance equations "piggyback" on an open loop reference trajectory until most of the programming errors had been corrected. The final step was to close the guidance loop and allow the guidance constants to fly the vehicle to lunar impact. This was then called the nominal trajectory and used as a reference in studying the dispersions caused by various disturbances such as variations in thrust, vehicle weight, and control parameters. From the tabulation results a determination was made of the capability of the guidance equations to achieve an acceptable burnout when disturbances were present. C.T.C.

N67-37810*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RESEARCH AND ADVANCED DEVELOPMENT. VOLUME I. SUPPORTING RESEARCH AND TECHNOLOGY FOR THE OFFICE OF SPACE SCIENCES AND APPLICATIONS, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION Semiannual Review, 1 Jan.–30 Jun. 1967
31 Jul. 1967 527 p refs
(Contract NAS7-100)
(NASA-CR-88536; JPL-TM-33-353) CFSTI: HC $3.00/MF $0.65 CSCL 22A

This volume of the semiannual review covers three main headings: lunar and planetary exploration, physics and astronomy, and bioscience. Lunar and planetary exploration research work summarized includes: space chemistry, planetology, planetary quarantine and sterilization, spacecraft and capsule equipment development, and spacecraft reliability, testing equipment, and techniques. Physics and astronomy topics comprise: magnetodynamics in space, solar physics, energetic particles, and fields and particles data analysis. Exobiology, planetary quarantine and sterilization, and an automated biological laboratory are bioscience topics considered. E.C.

N67-37820# California Inst. of Tech., Pasadena.
THEORY OF THE INTERPLANETARY MAGNETIC FIELD
Leverett Davis, Jr. *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 93–107 (See N67-37816 22-25)

The theory of the azimuthal magnetic field is considered with emphasis on the effects of the angular motion of the sun. ESRO

N67-37821*# California Inst. of Tech., Pasadena.
MAGNETIC FLUCTUATIONS IN THE MAGNETOSHEATH: MARINER IV
G. L. Siscoe, L. Davis, Jr., E. J. Smith (JPL), P. J. Coleman, Jr. (Calif. Univ., Los Angeles), and D. E. Jones (Brigham Young Univ.) *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 109–143 refs Submitted for publication (See N67-37816 22-25)
(Contract NASw-6; Grants NsG-426; NGR-45-001-011; NGR-05-007-065)

Mariner IV magnetometer data obtained in the earth's magnetosheath during a period of very low geomagnetic activity are analyzed to determine the character of the fluctuations observed in the magnetic field. Spectral analysis and plots of smoothed data indicate a generally high level of activity in the hydromagnetic regime and evidence for both compressional and torsional waves. A large amplitude oscillation composed of longitudinal and transverse components was observed with a period of approximately 200 sec. Compressional fluctuations in the frequency range 0.2 to 1.0 cps were of roughly constant intensity throughout the magnetosheath, increasing only slightly near the shock. Transverse fluctuations were smaller near the magnetopause and increased greatly as the shock was approached. Author (ESRO)

N67-37822# Imperial Coll. of Science and Technology, London (England).
THE RECONNECTION MODEL OF THE GEOMAGNETIC TAIL
J. W. Dungey *In* ESRO Plasmas in Space and in the Lab. Apr. 1967 p 151–170 refs (See N67-37816 22-25)

Consequences of the reconnection model are discussed for time-varying phenomena involving the tail and ground observations at high latitudes. It is shown that reconnection in the tail with a sudden onset accounts for numerous observed features of magnetic bays and auroral substorms. The Dessler model is a simple special case and is used to formulate some problems concerning the form of the tail. In the more general case the boundaries far from the equatorial plane need a fresh discussion and are found to be very

different from those commonly assumed as in the Dessler model. The plasma density in the tail is briefly discussed and a north–south asymmetry is suggested by the reconnection model.
Author (ESRO)

N67-37847*# Volt Technical Corp., Washington, D. C.
ABSOLUTE EXTRA-ATMOSPHERIC VALUES OF BRIGHTNESS AND ILLUMINATION IN THE SPECTRAL RANGE 2.7 μ–5.0 μ OF THE CONTINUOUS SOLAR SPECTRUM [ABSOLYUTNYYE VNEATMOSFERNYYE ZNACHENIYA YARKOSTI I OSVESHCHENNOSTI V NEPRERYVNOM SOLNECHNOM SPEKTRE V INTERVALE 2.7 μ–5.0 μ]
G. F. Sitnik 7 Sep. 1967 4 p refs Transl. into ENGLISH from Astron. Tsirkuliar Akad. Nauk SSSR (Kazan), no. 344, 26 Oct. 1965
(Contract NAS5-12487)
(NASA-CR-88875; ST-SP-SPC-10644) CFSTI: HC $3.00/MF $0.65 CSCL 03A

A table is presented of the derived relative brightness, the absolute brightness, and the monochromatic illumination at average distance from earth to sun. The measurements of the continuous solar spectrum were conducted in 1958 in the Tyan'-Shan' high mountain range with an IKS-6 spectrometer. The apparatus and the methods of measurement and calculation are briefly mentioned.
N.E.N.

N67-37908*# Volt Technical Corp., Washington, D. C.
FIRST PANORAMAS OF LUNA-13. DETERMINATION OF DENSITY AND MECHANICAL STRENGTH OF LUNAR LAYER AT THE LANDING SITE OF THE AUTOMATIC STATION LUNA-13
I. I. Cherkasov, A. L. Kemurdzhian, L. N. Mikhaylov, V. V. Mikheyev, A. A. Morozov et al 25 Aug. 1967 30 p refs Transl. into ENGLISH from the Russian preprint
(Contract NAS5-12487)
(NASA-CR-88874; ST-LPS-LSL-10640) CSCL 03B

Twelve lunar surface panoramas and data obtained from the Soviet automatic station Luna 13 indicate that its landing site was a layer of granular material with volumetric weight of 0.8 g/cm^3 or somewhat less. This layer consisted of grains and granules of porous mineral material that are loosely connected. Thickness of the layer at the groundmeter-penetrometer is considered to be not less than 5 cm, and numerous stones are thought to be scattered over the landing site. Details of the penetrometer are included, as are those for the radiation densimeter, which was designed to measure density of the upper layer of the lunar soil. Installation of devices on Luna 13 and landing of the instrumentation package are discussed.
M.W.R.

N67-37952*# Lincoln Lab., Mass. Inst. of Tech., Lexington.
RADAR STUDIES OF THE MOON Quarterly Progress Report
23 Nov. 1966 20 p refs
(Contract NSR-22-009-106)
(NASA-CR-88478; QPR-4) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The theory of thermal emission from the moon is reviewed, and the types of physical parameters which are related to it are defined. Lunar brightness temperature at microwave frequencies is considered, and it is shown that the variation of the temperature with lunar phase provides a direct measure of the ratio of penetration of thermal waves and electromagnetic waves; the accuracy of the determined ratio depends on the accuracy with which the surface temperature is known. Equations are derived for emission polarization. Procedures for taking and analyzing radiometric data are explained, and preliminary interpretations of the results are given. For high-resolution 3.8 cm reflectivity mapping, efforts centered on increasing the input ephemeris accuracy and improving the method of output mapping display. The problems involved in developing the instrumentation for the 8 mm radar studies are discussed.
M.G.J.

N67-37973*# IIT Research Inst., Chicago, Ill. Technology Center.
COMPOSITIONAL ANALYSIS OF LUNAR AND PLANETARY SURFACES USING NEUTRON CAPTURE GAMMA RAYS
John H. Reed 22 Mar. 1967 15 p
(Contract NASr-67(18))
(NASA-CR-88503; IITRI-A6155-3) CSCL 03B

The objective of this research program is to establish the practicality of using neutron capture gamma rays as a part of NASA's combined neutron experiment for lunar and planetary surface analysis. This requires (1) the determination of the sensitivity of the technique under reasonable field conditions with the experimental configuration optimized for the capture gamma-ray technique and (2) the determination of the effects which integration with other neutron techniques will have on its sensitivity. Capture gamma-ray spectra were studies from a large sample using a pulsed 14 MeV neutron source under a variety of experimental conditions. It has been determined that horizontal detection geometry yields better sensitivity than does vertical geometry and that a moderating material above the neutron source (about 4 to 8 cm thick) greatly increases the sensitivity of the capture gamma-ray technique.
Author

N67-37996* National Aeronautics and Space Administration, Washington, D. C.
THE EFFECT OF THE WEIGHT FACTORS ON THE OPTIMUM MOTION OF THE VARIABLE-MASS BODY WITH THE LIMITED VELOCITY JET [VLIYANIYE VESOVYKH FAKTOROV NA PARAMETRY OPTIMAL'NOGO DVIZHENIYE TELA PEREMENNOY MASSY ORGANICHNOY SKOROST'YU ISTECHENIYA STRUI]
G. L. Grodzovskiy Dec. 1966 18 p refs Transl. into ENGLISH from the Russian preprint
(NASA-TT-F-10439) CSCL 22A

The effect of the weight limitations imposed on the parameters of the propulsion system with the limited velocity jet on the optimum motion of the variable-mass body in the gravitational field is considered. An example of solution of the model problem on the maximum energy increase during the vertical climb in the uniform field in vacuum is presented.
Author

N67-38048*# Bellcomm, Inc., Washington, D. C.
COLLISIONAL MODEL OF METEOROIDS
J. S. Dohnanyi 10 Jul. 1967 45 p refs
(Contract NASw-417)
(NASA-CR-88864; TR-67-340-3) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A collisional model of meteoroids is formulated. An equation is derived which describes the evolution of a system of particles under the processes of particle destruction due to collisions and particle creation due to fragmentation during collisions. If the system of particles is assumed to have reached steady-state conditions it is found that a particle number density function of the simple form $Am^{-\alpha}dm$ (m is particle mass, A and α are constants) satisfies the equation provided that α has a value in the range $1/2(\eta+5/3)<\alpha<2$ where η is a material parameter having a value of about 1.8. Comparison with near earth meteoroid fluxes indicates

that the gross features of the observed distribution are reproduced by the present model. Agreement is also found with the distribution of the cataloged asteroids. Author

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

N67-36804# Smithsonian Astrophysical Observatory, Cambridge, Mass.
SOUTH AFRICA BAKER–NUNN PHOTOGRAPHY OF THE PAGEOS-A INFLATION AND APOGEE BURN OF THE AGENA D
Werner Kirchhoff and James Latimer 30 Jun. 1967 25 p refs
(SAO Special Rept.-243)

The inflation of the PAGEOS-A geodetic balloon satellite was confirmed by photographic observations made by the Smithsonian Astrophysical Observatory's Baker–Nunn camera in South Africa. The observation included a 30-frame sequence of the Agena-D apogee thrust burn and the resulting cloud formations and dispersions. These interesting changes in cloud shapes indicate a field for further investigation. The film also contains 40 frames of the Agena D prior to apogee burn; if precisely reduced these should yield, accurate to 1 ft/sec, the actual velocity increase achieved from the burn. Author

N67-36788# Boeing Co., Seattle, Wash. Aerospace Group.
APPLICATION OF GROUND TEST DATA TO REENTRY VEHICLE DESIGN Technical Report, Jun. 1965–Dec. 1966
Alfred C. Thomas and Andrew Perlbachs Wright-Patterson AFB, Ohio. AF Flight Dyn. Lab., Jan. 1967 138 p refs
(Contract AF 33(615)-2516)
(AFFDL-TR-66-229; AD-655383)

Methods and procedures were developed for extrapolating ground-test aerothermodynamic data to flight conditions for four geometric elements. These elements are a sharp unyawed delta wing, deflected control surfaces in compression and expansion, surface roughness elements typified by shallow convex surface waves and rectangular grooves, and a yawed circular cylinder intersecting a sharp flat plate. Graphs and charts are provided for rapid numerical computation of factors to be used in extrapolating the wind-tunnel data for these geometric elements to flight conditions. An evaluation of the simulation capabilities of operational hypersonic ground facilities is also included. Author (TAB)

N67-36792*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.
ORBITAL EXPERIMENT CAPSULE FEASIBILITY STUDY. VOLUME I: SUMMARY Final Report
S. Urcis Sep. 1967 242 p refs
(Contract NAS2-4236)
(NASA-CR-73128; SSD-70384R, Vol. I) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The Orbital Experiment Capsule (OEC) will be a scientific satellite of Mars to be initially carried piggy-back on the Voyager spacecraft and ejected from it upon completion of the operational phase between the Voyager spacecraft and the Voyager Lander. This study represents a feasibility assessment for the purpose of defining mission philosophy, profile, and design. The following are covered in this volume: (1) OEC configuration, operation characteristics, Voyager requirements, and cost estimates; (2) systems analyses, including orbit determinations, OEC ejection, and attitude stabilization and control; (3) communications and data handling; (4) power, propulsion, structure, thermal control, and sensors subsystems; (5) magnetic cleanliness; and (6) OEC reliability. K.W.

N67-36825# Ballistic Research Labs., Aberdeen Proving Ground, Md.
FIVE-INCH HARP SYSTEM—INITIAL TEST SERIES—FORT GREELEY, ALASKA
Eugene D. Boyer and L. Edwin Williamson (White Sands Missile Range) May 1967 20 p refs
(BRL-TN-1657; AD-655267)

The use of a 5-inch HARP system for meteorological soundings under artic conditions has been proposed. Feasibility tests for soundings to 200,000 feet (the present M33 radar limit) with present compatible payloads are discussed. Author (TAB)

N67-36835* Boeing Co., Seattle, Wash. Space Div.
LUNAR ORBITER ADAPTABILITY TO OTHER SCIENTIFIC INVESTIGATIONS, VOLUME II Final Report
D. W. Exner, Jr. 7 Aug. 1965 95 p
(Contract NAS1-4959)
(NASA-CR-66449; D2-100369-2, Vol. II) CSCL 22B

General descriptive data are presented on the Block I lunar orbiter to provide background information on the adaptability of the spacecraft to other scientific investigations. Mission objectives are defined, and the launch vehicle and spacecraft configurations are discussed and depicted. Brief descriptions are included on the photo, power, communications, attitude control, velocity control, and thermal control subsystems, and the on-line supporting ground based equipment. M.G.J.

N67-36836# Army Engineer Waterways Experiment Station, Vicksburg, Miss.
ROCKET ENGINE JET BLAST ATTENUATION IN WATER
G. W. Leese Jun. 1967 31 p refs *Its* Misc. Paper no. 4-903
(AD-654507)

The investigation was conducted to determine the feasibility of launching missiles and superboosters from overwater sites. Information is needed to predict the depth of liquid-propellant rocket engine exhaust gas penetration into water. Methods will be required to minimize the depth of blast penetration and the upward splash of water. Since these large vehicles will generate high levels of noise during static test firing or lift-off, some method of noise suppression is desired in order to control possible harmful conditions for working personnel and to limit the size of the required test or launch area. Overwater blast tests with small-scale rocket engines of 250-, 500-, and 1000-lb thrusts were conducted (a) without underwater devices, (b) with underwater screens, and (c) with an underwater deflecting device exhausting into a group of cylindrical screens. Based on the results of this study, the following conclusions are believed warranted: (a) The rocket engine exhaust blast-penetration tests show that a relation exists between height of engine above the water, engine thrust, and depth of blast penetration into the water. (b) Depth of blast penetration can be reduced by an underwater deflecting device. (c) Splash action and noise intensity can be reduced by the use of an underwater deflector which directs the exhaust into a number of horizontal concentric, cylindrical screens. Author (TAB)

N67-36843# European Space Research Organization, Paris (France).
PROPOSAL FOR A DEVELOPMENT PROGRAMME OF EUROPEAN TELECOMMUNICATIONS SATELLITES, VOLUME 6. PART II: ORGANISATION AND MANAGEMENT OF THE PROGRAMME. PART III: TIME SCHEDULE. PART IV: FINANCIAL ESTIMATES
Jun. 1967 150 p refs
CFSTI: HC $3.00/MF $0.65

The report deals with the organization and management of the program, the time required for implementing it (first attempt to place the satellite in orbit would be end of June 1971), and the cost analysis of the program. Author (ESRO)

N67-36917*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DATA PROCESSING PLAN INTERPLANETARY MONITORING PLATFORM-F IMP F. VOLUME I: THE SPACECRAFT. VOLUME II: THE DATA PROCESSING
Jul. 1967 343 p
(NASA-TM-X-55892; X-563-67-311, Vol. I; X-563-67-311, Vol. II) CSCL 22B

Methods and procedures to be used to process analog telemetry data received from the IMP F spacecraft are presented. The data processing plan; and the spacecraft and its mission are described. Scientific experiments conducted, the command system, tracking and data acquisition, flight operations, ground command support, telecommunications, the orbit, and the encoder format are discussed. In addition, the computer tape system, F-9 line, CDC 3200 computer programs, Univac 1108 computer programs, maintenance, and inspection and quality control procedures are also discussed. L.S.

N67-36938*# National Aeronautics and Space Administration, Washington, D. C.
THE PIONEER SPACECRAFT
[1967] 8 p
(NASA Facts, Vol. IV, No. 3; NASA Facts-NF-31) GPO: $0.10 CSCL 22B

A fact sheet is presented on the salient features of the sun-orbiting Pioneer spacecraft. The interplanetary space monitoring objectives are defined, and the scientific data obtained from Pioneers V, VI, and VII are discussed. Nontechnical details are given on the spacecraft design and construction, and on the contact with Pioneer maintained by the Deep Space Network. M.G.J.

N67-36989*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
DESIGN CONSIDERATIONS FOR ORBITAL TRANSPORT SYSTEMS
Dietrich W. Fellenz and Charles M. Akridge 20 July 1967 38 p refs
(NASA-TM-X-53636) CSCL 22B

Applications of Earth orbital platforms and satellites show that a solid basis exists for expansion of Earth-orbital operations. Present projections of manned and unmanned orbital launch requirements indicate that more economic means of space transportation will be needed. Starting from present day hardware, the question whether to simplify or sophisticate vehicle concepts is examined, and two problem areas are considered: (1) implications of operational requirements on systems design, performance and cost, mission parameters, man's safety and comfort, overflight of populated areas, sonic boom, abort and flyback capability, and vehicle turn-around; and (2) the implementation of systems development, specifically the problem of a quantum jump requiring a large, concentrated development expenditure versus a more modestly paced evolutionary approach in which annual funding and development risk are limited. Various approaches and their systems sensitivities were put into context with a mission model and evaluated for utility, cost, and development risk. Discussed are also reusable passenger vehicle designs for orbital use to replace the Apollo command and service modules, other partially reusable systems, and improvements in launch vehicles. K.W.

N67-37043*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
GEMINI RELIABILITY AND QUALIFICATION EXPERIENCE
W. Harry Douglas 1967 36 p Presented at the NATO Advisory Group for Aeronautical Res. and Develop., Guidance and Control Panel Symp., Paris, 7–8 Mar. 1967
(NASA-TM-X-60372) CFSTI: HC $3.00/MF $0.65 CSCL 14D

In optimizing the reliability and qualification program, emphasis was placed on establishing high inherent reliability and low crew-hazard characteristics early in the design phases of the Gemini Program. Stringent numerical design goals for mission success and crew safety were placed on the contractor who incorporated these goals in each specification written for flight hardware. Design reviews were conducted by engineers to insure unbiased evaluations and were completed prior to specification approval and the release of production drawings. Redundant systems or backup procedures were provided where a single failure could prove catastrophic. A closed-loop failure reporting and corrective action system was adopted which required the analysis, determination of the cause, and corrective action for all failures, malfunctions, or anomalies. The integrated ground test program consisted of development, qualification, and reliability tests conducted under rigid quality control surveillance. The application of these criteria to the guidance and control system is discussed. M.G.J.

N67-37074*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
ENTRY FLIGHT AERODYNAMICS FROM APOLLO MISSION AS-202
Ernest R. Hillje Washington, NASA, Oct. 1967 61 p refs
(NASA-TN-D-4185) CFSTI: $3.00 CSCL 22B

Inertial-platform accelerations and attitudes were used with trajectory data to calculate the flight aerodynamic characteristics of the entry configuration (command module). The flight results, in the form of aerodynamic angles, force coefficients, and coefficient ratios, were compared with trimmed wind-tunnel data predictions and with wind-tunnel data adjusted to the flight angle of attack. The comparisons showed the flight trim angle of attack to be higher than predicted at the initial high-Mach-number, low-Reynolds-number entry conditions, resulting in a corresponding low (18 percent) lift-to-drag ratio. Both flight angle of attack and lift-to-drag ratio were essentially linear down to the high-supersonic-Mach-number region where there was good agreement with the predicted values. The areas of poor agreement were caused by poor trim-angle predictions and not by poor wind-tunnel resultant force data. Author

N67-37173*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.
ORBITAL EXPERIMENT CAPSULE FEASIBILITY STUDY. VOLUME II: SUPPORTING TECHNICAL STUDIES AND TRADEOFFS Final Report
Sep. 1967 422 p refs
(Contract NAS2-4236)
(NASA-CR-73127; SSD-70385R) CSCL 22B

Analytical data are presented on studies conducted to determine whether a satellite can be ejected from the Voyager

1973 Orbiter and positioned in a preferential orbit about Mars. The characteristics of the Voyager–Orbital Experiment Capsule (OEC) are described, with consideration given to the two mission extremes defined as a coorbiter and an orbit change concept. Scientific experiments for detecting various measurables of the Martian environment are discussed. Studies and tradeoffs are detailed on communications and data handling, configurations, subsystems, magnetic control, and OEC reliability. Mathematical analyses are presented on attitude and orbit determination, and oscillator drift effects on multiple frequency shift keying. Preliminary calculations are included on the use of the Canopus sensor as a roll reference. An OEC configuration and mission profile is recommended to meet the performance requirements; additional flexibility is incorporated to enhance the mission's scientific objectives. M.G.J.

N67-37193 Defence Research Board, Ottawa (Ontario).
ALOUETTE I IONOSPHERIC DATA INTERPOLATED N(h), VOLUME 2
1 Aug. 1967 483 p

The electron number density at heights ranging from 250 to 1000 km in increments of 50 km are tabulated for the real height profiles of Alouette I ionospheric data. The number densities at these heights are determined from the data by linear interpolations in plasma frequency. The tabulations include data on the year and date, GMT of observation, local mean time at the satellite, geographic latitude and longitude of the satellite, satellite height in kilometers, geomagnetic latitude of the satellite, dip angle of the geomagnetic field at the satellite, gyrofrequency at the satellite, and a quality figure for the profile. R.N.A.

N67-37258*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
VENUS/MERCURY SWINGBY WITH VENUS CAPSULE. PRELIMINARY SCIENCE OBJECTIVES AND EXPERIMENTS FOR USE IN ADVANCED MISSION STUDIES
Roy G. Brereton, Ray L. Newburn, Jr., William S. McDonald, Frank T. Barath, Alan G. Herriman et al 1 May 1967 31 p refs
(Contract NAS7-100)
(NASA-CR-88488; JPL-TM-33-332) CFSTI: HC $3.00/MF $0.65 CSCL 22B

This document describes several possible scientific objectives with their supporting experiments and also provides the scientific information for a preliminary mission study of a Mariner-type spacecraft to be flown in a swingby trajectory to the planet Mercury via a close encounter with the planet Venus during the 1970–1973 period. It has been proposed that trajectories using the gravitational perturbations of Venus can be used to achieve a lower launch velocity mission to Mercury. Similar calculations have been made for other opportunities in the 1970s, and they suggest flyby distances from both Venus and Mercury that are very favorable for scientific observations. Further, these trajectories provide an opportunity for an occultation experiment on Venus, and under limited circumstances, on Mercury and the outer portion of the Solar Corona. The launch vehicle assumed for this mission study will possess at least the capabilities of an Atlas/Centaur: a Mariner-type spacecraft weighing upwards from 1300 lb for the 1970 opportunity, and 1000 lb for the 1973 opportunity. The most reasonable opportunity in the 1970–80 decade for a Venus/Mercury swingby mission appears to be in 1973 with launch between October 20 and November 11, and for a fixed Venus arrival date of February 5, 1974. It is concluded that a Venus/Mercury swingby-type mission appears to be very desirable and practicable from the scientific point of view as it offers an unusual opportunity in an early mission to visit two planets and obtain data relating to a variety of scientific problems. Author

N67-37275*# Boeing Co., Seattle, Wash.
LUNAR ORBITER III. MISSION SYSTEM PERFORMANCE Final Report
11 Aug. 1967 175 p refs
(Contract NAS1-3800)
(NASA-CR-66461; D2-100753-3) CSCL 22B

The spacecraft processing, tracking and telemetry coverage, and performance of the Atlas and Agena Launch Vehicles during the Launch Operations Plan are described. Flight operations for the Lunar Orbiter Mission III from liftoff through the completion of final readout are also described. Performance summaries of the photographic, communications, power, attitude control, and velocity control subsystems are presented. Also discussed are the performance of the ground data system; lunar environmental data; and various structures associated with the mission spacecraft. L.S.

N67-37290# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
PERFORMANCE OF THE SPIN CONTROL SYSTEM OF THE DME—A SATELLITE
F. F. Mobley, J. W. Teener, R. D. Brown, and B. E. Tossman Jun. 1967 23 p refs
(Contract NOw-62-0604-c)
(TG-929; AD-656730)

The Direct Measurement Explorer-A (DME-A) satellite was launched in November 1965 into a near-earth orbit ranging between altitudes of 500 and 3000 km to sample and measure charged particles. The attitude control system is used to keep the spin axis aligned with the orbit normal and to maintain the spin rate. Spin axis control is achieved by a chargeable permanent magnet system which is operated upon command and reacts with the earths field to produce precession of several degrees per minute. With this system the spin axis was kept within 10 degrees of the orbit normal for several weeks at a time, although larger deviations have been tolerated. The spin rate was observed to decay at 0.05 rpm per day. Periodic use of the spin rate control system has compensated for spin decay. This system is analogous to a DC motor in which the entire satellite is the armature. Author (TAB)

N67-37308*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PROJECT FIRE FLIGHT 1 VIBRATION DATA
Herbert A. Leybold, Henry T. Thornton, Jr., Robert N. Hancock, and E. D. Griffith (Ling-Temco-Vought, Inc., Dallas, Tex.) Washington, NASA, Oct. 1967 148 p
(NASA-TM-X-1415) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Three channels of vibration data were recorded during Project Fire Flight 1. An analog type reduction of the data was made and consisted of determining, in engineering units, such quantities as power spectral density, average spectral density, probability density, auto-correlation, cross-correlation, and cross-power spectral density for significant events during the flight. The results of this analysis are presented. Author

N67-37335* National Aeronautics and Space Administration, Washington, D. C.
FIFTH SURVEYOR SOFT-LANDER DUE FOR LAUNCH
31 Aug. 1967 43 p
(NASA News Release-67-227) Available from the Scientific and Technical Information Facility CSCL 22B

A press kit on Surveyor E and its scheduled launching and soft-landing is presented. The alpha scattering instrument for studying the chemical characteristics of the lunar surface is described. The spacecraft subsystems and instrumentation are outlined, and the Atlas Centaur launch vehicle characteristics and

flight sequence are reviewed. The tracking and communication procedures at the Deep Space Network and the Space Flight Operations Facility are summarized. The flight plan events, midcourse maneuver, terminal sequence, and post-landing events are covered. N.E.N.

N67-37345*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37-46, VOLUME VI FOR THE PERIOD MAY 1, 1967 TO JUNE 30, 1967. SPACE EXPLORATION PROGRAMS AND SPACE SCIENCES
31 Jul. 1967 28 p ref
(Contract NAS7-100)
(NASA-CR-88737; JPL-SPS-37-46, Vol. VI) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Progress is reported for the Surveyor, Mariner Venus 67, and Mariner Mars 1969 projects; as well as for Deep Space Network (DSN) capabilities and facilities and Deep Space Instrumentation Facility (DSIF) development and operations. The Surveyor III spacecraft launch and operational capabilities are reported; and mention is made of the fifth, sixth, and seventh flight spacecraft for Surveyor missions as well as of the modified S-9 test model. Principal investigators are listed for both of the Mariner projects, and Mariner Mars 1969 spacecraft design changes and weights are tabulated. Ground communications and space flight operations are considered for the DSN; and flight project support, DSS equipment installation and testing, and communications testing and development are covered for the DSIF. M.W.R.

N67-37347# European Space Research Organization, Paris (France).
PROPOSAL FOR A DEVELOPMENT PROGRAM OF EUROPEAN TELECOMMUNICATIONS SATELLITES, VOLUME 4. PART I: TECHNICAL STUDY
Jun. 1967 127 p refs
CFSTI: HC $3.00/MF $0.65

Placing the geostationary satellite in orbit, positioning, and station keeping are discussed in terms of responsibilities and facilities of the CNES, ELDO, and ESRO participants. Overall design, launch operations, and technical supervision and monitoring are considered. Details are included for the ESRO Redu station and its role in monitoring a geostationary satellite; and mention is made of the French Guiana launching range, the ELDO station at Gove, and the ESRO station at Port Stanley. Details for both control and mobile stations are included. M.W.R.

N67-37348# European Space Research Organization, Paris (France).
PROPOSAL FOR A DEVELOPMENT PROGRAM OF EUROPEAN TELECOMMUNICATIONS SATELLITES, VOLUME 5. PART I: TECHNICAL STUDY
Jun. 1967 95 p refs
CFSTI: HC $3.00/MF $0.65

Evaluation of the performance of the X92 satellite and ground station system will include confirmation of the suitability of the ELDO-PAS launcher telecommunications satellite missions, technological evaluation of satellite behavior, and performance measurements of the telecommunications link. The research and development program covers systems studies, and considers the directions for technological development. Contracts will be placed for research work concerning systems and orbit studies, energy supply, attitude control and orbit corrections, communications and electronics, and component parts and materials. ESRO

N67-37400*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
DESIGN AND FABRICATION CONSIDERATIONS FOR A 1/10-SCALE REPLICA MODEL OF THE APOLLO/SATURN V
Sumner A. Leadbetter, H. Wayne Leonard, and E. John Brock, Jr.
Washington, NASA, Oct. 1967 81 p refs
(NASA-TN-D-4138) CFSTI: HC $3.00/MF $0.65 CSCL 22D

A model of the Apollo/Saturn V launch vehicle was constructed for studies of vehicle dynamics. This model was designed to duplicate, in miniature, as many of the full-scale structural elements as was economically and technically feasible. The project represents advancements in the state of the art of dynamic modeling and exemplifies the current limit of practical accomplishment in construction of dynamic models. The design philosophy is outlined, the model is described as it relates to the prototype, and solutions to some design and fabrication problems which were encountered are documented. It is believed that the experience gained in the design and construction of the model will provide designers of future models with an insight to the pitfalls and compromises which may dictate deviations from true miniature reproduction of certain hardware items. Subsystems, such as plumbing, pressurization systems, and suspension systems, are discussed along with simulated components, such as propellant and oxidizer liquid masses. Author

N67-37452# European Space Research Organization, Paris (France).
PROPOSAL FOR A DEVELOPMENT PROGRAMME OF EUROPEAN TELECOMMUNICATIONS SATELLITES, VOLUME 3. PART I: TECHNICAL STUDY
Jun. 1967 374 p refs
CFSTI: HC $3.00/MF $0.65

A general definition is given of the mission of the satellite, e.g. reception of the program, television distribution to Europe and any point on the globe, intercontinental television relay, simultaneous retransmission of two-colour television programs. For both versions of satellites, the attitude control and orbit correction systems are described in detail as well as the telecommunications antennas and the television frequency translation repeaters. The power supply, telemetry and telecommand equipment, and the structure of the satellite are discussed. A thermal study concludes the report. Author (ESRO)

N67-37583# Atlantic Research Corp., Costa Mesa, Calif. Missile Systems Div.
THE DEVELOPMENT OF DESIGN TECHNIQUES FOR SINGLE-STAGE SOUNDING ROCKETS Final Report, 1 Jun. 1966-15 Mar. 1967
Robert L. Ammons 15 Mar. 1967 78 p refs
(Contract AF 19(628)-6051)
(AFCRL-67-0233; AD-652284) CFSTI: HC $3.00/MF $0.65

Techniques of designing minimum weight rocket vehicles have been explored and a recommended procedure arrived at. Use of this procedure is demonstrated, as is use of statistical weight relationships. A generalized solution to the single-degree-of-freedom, point mass equations of motion is developed and demonstrated. Author (TAB)

N67-37575*# Chrysler Corp., Detroit, Mich.
OPTICAL TECHNOLOGY APOLLO EXTENSION SYSTEM. PART 1: PRESENTATION
27 Sep. 1966 113 p
(Contract NAS8-20256)
(NASA-CR-88704) CSCL 22B

A compilation is presented of the graphical displays and data used in the presentation on the optical technology Apollo

extension system (OTAES) program. Objectives are defined, and historical examples of space optical technology development are depicted. Experiments are visualized on isolation systems comparison, atmospheric physics, and precision tracking. Experiment integration is shown in terms of candidate missions. Spacecraft configurations and subsystem concepts are sketched, and commonality conclusions and planning recommendations are listed. M.G.J.

N67-37596*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SURVEYOR III MISSION REPORT. PART I: MISSION DESCRIPTION AND PERFORMANCE
1 Sep. 1967 206 p refs
(Contract NAS7-100)
(NASA-CR-88739; JPL-TR-32-1177) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Surveyor III, the third in a series of seven unmanned spacecraft designed to soft-land on the moon and return data, was launched from Cape Kennedy, Florida, on April 17, 1967. All established objectives for the mission were achieved. After a nominal lunar transit phase, a successful soft-landing, which included three separate touchdown events, was accomplished on April 20, 1967. The Surveyor III spacecraft was operated through the end of the lunar day (12 earth days) to provide a large quantity of new data from within a sizable crater on the lunar surface. Of special interest are the results, obtained via television pictures, of extensive operations conducted with a soil mechanics/surface sampler, an instrument which was included for the first time on this mission. Author

N67-37619*# Douglas Aircraft Co., Inc., Huntington Beach, Calif. Missile and Space Systems Div.
PROJECT THERMO-PHASE B PRIME
J. D. Schweikle and G. O. Fredrickson Sep. 1967 293 p refs
(Contract NAS8-21129)
(NASA-CR-88712; DAC-60799) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The possibilities were explored of individual experimentation using smaller carrier vehicles with experiments aimed at providing cryogenic technology required for future manned planetary fly-by and landing missions. Technology requirements were investigated in the areas of propellant tank venting, long term propellant storage, propellant control, life support, and propellant transfer. Vehicles considered were the S-IIB, S-IVC, and a modular nuclear stage. Carrier capabilities and experiment conceptual design constraints are defined in terms of propellant transfer, boiling heat transfer and boilover, interface stability, stratification–destratification, and high performance insulation. Critical technology problem areas are identified as cryogenic storage tank pressure control, low g venting, propellant slosh control during maneuvers, ullage control during propellant outflow, propellant transfer receiver tank thermodynamics, life support system design, propellant mass gauging, and orbital engine restart. It is estimated that each recommended experiment conceptual design will cost about $6.5 million. M.G.J.

N67-37685# European Space Research Lab., Noordwijk (Netherlands).
SCIENTIFIC EXPERIMENTS IN ESRO SATELLITE PROJECT TD-1
W. de Graaff Paris, ESRO, Mar. 1967 28 p refs
(ESRO-SN-64) CFSTI: HC $3.00/MF $0.65

This note describes the scientific experiments which were accepted for the astronomical satellite payload TD-1 on 1st Oct. 1966. The TD-1 satellite will be launched into a near polar, circular orbit with an altitude of about 500 km. One axis of the satellite body will be stabilized onto the sun; another axis will be constrained to the plane containing the satellite, the sun and the earth's center. Thus, the satellite is suitable for solar monitoring experiments as well as for experiments scanning the sky. Four stellar experiments are included in the payload, two of which will scan the sky in the ultraviolet region below 3000 Å. A third stellar experiment will scan the sky in the X-ray region between 3 and 30 keV, and a fourth will measure gamma rays in the range 70 to 300 MeV. Two solar experiments will monitor the gamma radiation between 50 and 300 MeV, and the X-ray radiation between 20 and 300 keV. The last experiment will analyze the charge spectrum of the primary cosmic radiation for energies higher than 30 MeV. The scientific significance of the experiments is also indicated. Author (ESRO)

N67-37807# Utah Univ., Salt Lake City. Upper Air Research Lab.
THE DEVELOPMENT OF A GERDIEN CONDENSER FOR SOUNDING ROCKETS
David A. Burt May 1967 55 p refs
(Contract AF 19(628)-4995)
(UU-67-3; SR-8; AFCRL-67-0343; AD-655808)

Measurements of D-region conductivity are of extreme importance in understanding the basic, normal atmospheric processes as well as for investigating special events associated with the D-region, i.e., auroral absorptions, polar cap absorptions (PCA) and sudden ionospheric disturbances (SID). This report discusses the theory and possibilities of adapting one type of conductivity probe, the Gerdien condenser for operation on sounding rockets at supersonic and subsonic velocities. Details are presented for two systems developed for making correlating measurements during simultaneous rocket flights. The first is designed for the Black Brant II rocket (supersonic flow); and the second, employing a parachute system, is designed for the Arcas rocket (subsonic flow). Author (TAB)

N67-37811* Boeing Co., Seattle, Wash.
RELIABILITY ANALYSES AND SUPPORTING DATA—LUNAR ORBITER
Thomas Weston [1964] 89 p refs
(Contract NAS1-3800)
(NASA-CR-66459; D2-100255) CSCL 22B

Continuing inherent reliability analysis for the Lunar Orbiter System based on data available up to fifteen days prior to the document release date is provided. In support of this analysis the prediction model, factors used, and failure rate data sources are included. The model, predictions (analyses) based on this model and supporting data are revised and updated as required on a monthly basis. The information used in constructing the model was obtained from the functional block diagrams, parts counts, and determinations of duty cycles according to the best estimates of the subsystem designers. The 720 hour E-1 photographic mission is used for this analysis. The models and predictions of mission success are used as the basis for analytically comparing the current reliability status with the goals, and for trade studies between the various design parameters, such as weight and power requirements. Author

N67-37878* Lockheed Missiles and Space Co., Huntsville, Ala. Research and Development Center.
EXPERIMENTAL DAMPING STUDIES Final Report
C. Chang 6 Jan. 1966 216 p
(Contract NAS8-20088)
(NASA-CR-88873; HREC/0088-1; LMSC/HREC-A712619) CSCL 22D

This damping study experimented with methods of measuring structure damping, with emphasis placed on those methods which employ the minimum amount of assumptions prior to actual measurement. A 1/5-scale structural model of the Saturn I launch

vehicle SA-1 was chosen as the test sample. The model, with its eight loosely connected fuel and oxidizer tanks in the first stage, offers the complexity which can be expected in full-scale testing of both the Saturn I and the Saturn IB vehicles. Methods of damping determination applicable to the model can be applied to full-scale testing. The general approach for damping measurements is discussed, and specific objectives are outlined. A detailed description of the experimental work is given, and is followed by an analysis of data. Based on conclusions, a set of recommendations is formulated for experimental approaches, and for data analysis techniques in the future. Author

N67-37935*# General Electric Co., Daytona Beach, Fla. Apollo Support Dept.

THE MERCURY–REDSTONE PROJECT

F. E. Miller, J. L. Cassidy, J. C. Leveye, and R. I. Johnson Huntsville, Ala., NASA. Marshall Space Flight Center, Dec. 1964 278 p refs

(NASA-TM-X-53107) CFSTI: HC$3.00/MF$0.65 CSCL 22B

An historical account is presented on the development of the first American manned launch vehicle. The significance of this Mercury–Redstone project and its contribution to the design and operation of future manned launch vehicles are delineated. Details are given on the mission objectives and profile, the Mercury vehicle, the man-rating program to achieve crew safety, the development and reliability test programs, checkout and launch operations, and the flight tests. The specific equipments developed, which are still applicable for current manned launch vehicle programs, are identified as emergency egress operations with a mobile aerial tower and an armored emergency rescue vehicle; abort impact predictor for premature mission termination; the white room enclosing the spacecraft within the launch pad service structure; automatic inflight abort sensing system; range safety destruct procedures and implementation; and prelaunch weather survey techniques. M.G.J.

N67-38063*# Space Data Corp., Phoenix, Ariz.

CAJUN DART 95 KILOMETER SOUNDING ROCKET

Bruce Bollermann and Robert L. Walker 29 Aug. 1967 47 p

(Contract NAS8-20687)

(NASA-CR-61175) CFSTI: HC$3.00/MF$0.65 CSCL 22B

The Cajun Dart vehicle has been developed to conduct low cost meteorological soundings to altitudes of 95 kilometers (310,000 feet). The vehicle consists of a first-stage Cajun solid-propellant rocket motor and a second-stage non-propulsive dart. Rocket motor burnout occurs in a few seconds and at a low altitude. A high velocity is imparted to the dart which separates from the motor and coasts to apogee. Since the dart has a high ballistic coefficient, the drag losses of the system are minimized. The wind-measurement payload which has been used with the Cajun Dart consists of thin Mylar chaff strips which have been aluminized for radar reflection. This chaff payload is ejected at apogee altitude, and a radar track of the resulting chaff cloud provides wind information from 65 to 90 kilometers (215,000 to 295,000 feet). Other small diameter payloads, such as inflatable spheres, have been flown with the Cajun Dart. Author

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N67-38089# Pennsylvania State Univ., University Park. Dept. of Engineering Mechanics.

ANALYSIS OF TOROIDAL SHELLS WITH INITIAL DISPLACEMENTS

J. Kiusalaas and K. S. Dhanju Jun. 1967 59 p refs

(Contract DA-31-124-ARO(D)293)

(AROD-5102.4-E; TR-1; AD-655520)

An approximate method for analyzing toroidal shells by linear bending theory is presented. Special emphasis is placed on the influence of initial displacements of the meridian, due to manufacturing imperfections, in determining the stresses and displacements of the shells. The results of the analysis are compared with strain gage readings for the case of uniform normal pressure. A reasonable agreement is obtained only if the effects of the imperfections are included in the analysis. Methods of solution for axial forces and centrifugal loads are also given; the former is shown to be insensitive to the initial displacements, while the sensitivity of the latter depends on the source of the loading (fluid enclosed in the shell or the shell material itself). Author (TAB)

N67-36737 Lockheed Missiles and Space Co., Sunnyvale, Calif.

ON WAVE PROPAGATION IN THREE-DIMENSIONAL ELASTOPLASTIC BODIES UNDER TOTAL PLASTICITY CONDITIONS

G. I. Bykovtsev, A. A. Kaluzhin, and L. D. Kretova [1967] 9 p refs Transl. into ENGLISH from Inzh. Zh.: Mekh. Tverdogo Tela (USSR), no. 3, 1967 p 13–20

Explicit expressions are obtained for the wave propagation velocities and for the relationships characterizing the magnitudes of the jumps in elastoplastic bodies for stress states corresponding to the edge of a Tresk prism. The wave is understood to be a propagating surface on which the accelerations undergo jumps. The elastic and plastic parts of the total strain rates in an elastoplastic material are considered, and the changes in wave intensity are investigated. N.E.N.

N67-36794 Illinois Univ., Urbana.

STUDIES OF PROBABILISTIC SAFETY ANALYSIS OF STRUCTURES AND STRUCTURAL SYSTEMS

A. H.-S. Ang and M. Amin Mar. 1967 60 p refs /tz Struct. Res. Ser. No. 320

The purpose of this study is (1) to clarify assumptions necessary for the evaluation of structures and structural systems, and (2) to establish reliable mathematical formulations for the analysis of structural safety consistent with realistic physical assumptions. The highest lower bound and the lowest upper bound reliabilities of linear structures and structural systems are identified and mathematically derived in terms of failure probability under the first load. The risk function resulting from repeated loadings is examined for a class of structures important in civil engineering. Safety and reliability of structural systems are discussed, and upper and lower bound reliabilities of determinate and indeterminate systems are identified. A mathematical model is described which evaluates the probability of collapse of general indeterminate systems. The systems may be assemblages of ductile or brittle members. Expressions are developed for the probability distribution functions of the ultimate capacities of simple indeterminate systems in terms of the resistance distribution function of individual components. K.W.

N67-36798# California Univ., La Jolla. Dept. of the Aerospace and Mechanical Engineering Sciences.

OPTIMUM CRITICAL IMPULSE FOR SNAP-THROUGH IN SYSTEMS OF ONE DEGREE OF FREEDOM Interim Scientific Report

N. C. Huang, W. Nachbar, and W. Prager Jul. 1967 34 p refs
(Grant AF AFOSR-1226-67)
(AFOSR-67-1511; TR-3; AD-655839)

A general procedure is derived for evaluation of the optimum load history which can cause the snap-through of a nonlinear, dissipative dynamical system of one degree of freedom in such a manner that the total impulse delivered by the load is a minimum. For systems in which dissipative force either is absent or else depends linearly on velocity, the optimum load history for minimum impulse is shown to be an ideal (Dirac-delta function) impulse applied to the system at rest. For nonlinear dissipation, however, the optimum load history has, in general, loads of finite magnitude acting over finite time. A general procedure to determine the optimum load history and the minimum total impulse for nonlinear dissipation is developed. This procedure is illustrated by application to two problems: the circulation of a single pendulum with damping; the snap-through of a simple, nonlinearly viscoelastic truss. Author (TAB)

N67-36816 Lockheed Missiles and Space Co., Sunnyvale, Calif.
REPRESENTATION OF THE EIGENVALUES OF THE FIRST BOUNDARY VALUE PROBLEM OF ELASTICITY THEORY IN TERMS OF A CONTOUR INTEGRAL
T. Azhymudinov and G. Mamaturdiev [1967] 7 p refs Transl. into ENGLISH from Izv. Akad. Nauk Uz. SSR, Ser. Fiz. Mat. Nauk (Tashkent), no. 3, 1967 p 3–9

A mathematical discussion is presented on the elasticity theory, and on eigenvalues found in terms of countour integral. The condition of quality derived through the series of equations proves the theorem on the negativity and realness of the eigennumbers of the considered problem, which was obtained earlier by another method. The formula is easily extended to the n-dimensional case. R.U.

N67-36853 Royal Aircraft Establishment, Farnborough (England).
A RELAXATION PROCEDURE FOR COMPUTING STRESSES IN BUILT-UP STRUCTURES
E. C. Capey Mar. 1967 42 p refs
(RAE-TR-67062)

A method is presented for computing the stress distribution in a thin-walled structure by dividing the structure into finite elements, setting up plane stress equations for each element and solving these by an iterative procedure. Its merits are simplicity of application and economy of computer storage space and operation time. The method is applied to a simple plane stress problem and to a built-up structure. Its accuracy is tested by comparing results obtained for the plane stress problem with the known closed form solution, and by comparing together results obtained for the built-up structure using different element sizes. Author

N67-36905 Royal Aircraft Establishment, Farnborough (England).
ON THE STRESSES NEAR A CRACK IN AN ELASTIC SHEET
E. H. Mansfield Jan. 1967 24 p refs
(RAE-TR-67030)

This report considers the two-dimensional stresses near a crack in an infinite elastic sheet under uniform all-round tension. The analysis differs from classical theory in that account is taken of the varying shape of the crack. It is shown that in the vicinity of the tips of the crack the stresses increase non-linearly with the applied load; these stresses also depend on the magnitude of Young's modulus itself. Author

N67-36911# Seattle Univ., Wash. Dept. of Mechanical Engineering.
THERMAL FATIGUE DAMAGE UNDER A TWO-STRAIN-BLOCK HISTORY Final Report, 1 Jul. 1963–1 Jul. 1967
Harry Majors, Jr. Jun. 1967 119 p refs
(Contract DA-31-124-ARO(D)-145)
(AROD-4116-1-E; AD-656481)

Thermal-strain fatigue, two block strain cycling, axial tension-compression tests were performed on thin-walled tubes of annealed, type 200 nickel to study the plastic strain damage process that leads to failure in the range of 10,000 to 100,000 cycles at a mean temperature of 580F under a frequency of 60-90 cycles per hour. Plastic strain ranges are in the order of twenty to forty per cent of the total strain range. All tests showed a transient period in the first 100 cycles prior to the stress-strain hysteresis loops stabilizing. A cumulative damage theory was developed which led to the relationship for a two-strain block history. Author (TAB)

N67-36913*# Dynatech Corp., Cambridge, Mass.
VIBRATION STUDY OF A PRESSURIZED TORUS SHELL. PART II: DEVELOPMENT AND APPLICATIONS OF ANALYSIS
Atis A. Liepins Washington, NASA, Oct. 1967 48 p refs
(Contract NAS1-6632)
(NASA-CR-885) CFSTI: HC$3.00/MF$0.65 CSCL 20K

Previous work on the free vibrations of pressure prestressed toroidal shells is extended. Shells constructed of a number of toroidal segments, each with a constant thickness, and various boundary conditions are included. The analysis is then applied to simple models of a toroidal shell structure for which experimental results are published. The calculated fundamental frequency and mode shape of this shell agree well with the experimental results for three levels of internal pressure. Author

N67-36928 Aeronautical Research Council (Gt. Brit.)
A CONVENIENT PRESENTATION OF CREEP STRAIN FOR PROBLEMS INVOLVING TIME-VARYING STRESSES AND TEMPERATURES
J. M. Clarke 1967 25 p refs
(ARC-CP-945)

An empirical approach to the representation of observed creep strain behaviour for a wide range of times, stresses and temperatures is outlined. The formulae are unusual in permitting the representation of primary and tertiary creep behaviour without forfeiting the convenience of explicit expressions for the strain rate using either the strain or time hardening hypotheses. They are therefore particularly suited for use in stress redistribution calculations. A comparison is made between the usual expressions for stress dependence. A table lists the arbitrary constants chosen to fit the creep behaviour of the Nimonic alloys 80A, 90, 100 and 105. Author

N67-36930# Kaman Aircraft Corp., Colorado Springs, Colo. Kaman Nuclear Div.
MATHEMATICAL/STATISTICAL TECHNIQUE TO ESTIMATE MAXIMUM AEROSPACE VEHICLE RESPONSE TO WIND Final Report, Jun. 23, 1965–May 31, 1967
C. Eugene Buell 31 May 1967 215 p refs
(Contract AF 19(628)-5170)
(KN-67-663(FR); AFCRL-67-0394; AD-655809)

The statistical distribution of the maximum (per flight) resultant bending moment of an aerospace vehicle can be acquired in a brute-force manner from calculations of level-by-level bending moments during computer-simulated launchings through a representative sample of individual wind soundings. This distribution

resembles, closely, the Gumbel distribution. Calculated risk design philosophy in which the probability of failure is specified can be applied to this distribution to arrive at a final design configuration. To avoid extensive computer efforts required by this brute-force approach, the statistics of wind, interlevel covariances of and between wind components and wind shear components are used in connection with dynamical equations to compute the statistics of bending moment response in a single computer run. The parameters determined from these statistics for the distribution of maximum resulting bending moment per flight agree closely with those determined from the individual wind sounding method. Several other methods of treating the problem are discussed in view of simplification for the work and shortening the computations.
Author (TAB)

N67-36933# California Univ., La Jolla. Dept. of the Aerospace and Mechanical Engineering Sciences.
ON NONLINEAR STEADY-STATE SOLUTIONS TO MOVING LOAD PROBLEMS Interim Scientific Report
G. A. Hegemier Jun. 1967 28 p refs
(Grant AF AFOSR-1226-67)
(AFOSR-67-1439; TR-2; AD-655838)

In certain moving load problems involving elastic solids or structures with an idealized infinite or semi-infinite spatial domain, steady-state solutions of the governing equations of motion are frequently sought as an alternative to a more complex transient analysis. In seeking a solution of this type the implication is, of course, that it represents the limit of a transient problem. While this appears to be generally true of well-posed linear elastic problems, the same cannot be said of nonlinear elastic formulations. To substantiate this point the case of an infinite length string supported by a nonlinear elastic foundation and subjected to a concentrated load moving with constant velocity is studied in this paper. It is shown that although the steady-state solution of the problem is unique for load velocities both above and below the signal velocity of the string, that above is locally unstable and therefore cannot represent the limit of transient motions.
Author (TAB)

N67-37001# Structural Mechanics Associates, Narbeth, Pa.
A METHOD FOR WEIGHT OPTIMIZATION OF FLAT TRUSS-CORE SANDWICH PANELS UNDER LATERAL LOADS Final Report, 24 May 1965–31 Dec. 1966
John J. Mc Coy, Sidney Shore, and Jack R. Vinson Philadelphia, Pa., Naval Air Eng. Center, 15 Jun. 1967 71 p refs
(Contract N156-46654)
(NAEC-ASL-1111; AD-656054)

A method is presented for optimizing, on a weight basis, flat truss-core sandwich panels under lateral loads. To solve this type of problem by equating the stress level for all failure modes requires a knowledge of the stress distribution throughout the panel for the given loading. There are no available stress analysis methods of sufficient sophistication for corrugated panels under lateral loading; hence, a large portion of this report is devoted to the development of such a method of analysis. The method is essentially a deformation method; however, a technique of using Fourier type transformations makes the solution more tractable.
Author (TAB)

N67-37031*# Measurement Analysis Corp., Los Angeles, Calif.
THE MAXIMUM RESPONSE OF RECTANGULAR PLATES TO RANDOM EXCITATION
Richard L. Barnoski Washington, NASA, Sep. 1967 45 p refs
(Contract NAS8-20020)
(NASA-CR-853) CFSTI: HC $3.00/MF $0.65 CSCL 20K

This report considers empirical solutions to the first-passage or single-highest-peak (SHP) problem for a distributed elastic structure with rectangular geometry subjected to both stationary and a specific form of nonstationary random excitation. The structure is a flat, homogeneous, uniform, square plate and the applied stationary excitation is white noise perfectly correlated in both space and time. The nonstationary excitation is a rectangular noise burst with a unity correlation in both space and time. The structure and the excitation are simulated electrically and peak response data are collected for (1) simply supported boundary conditions at all edges and (2) rigidly clamped boundary conditions at all edges. These response data are used to establish probability curves yielding an estimate of the probability that the maximum response, for a finite time interval, remains below a preselected threshold level.
Author

N67-37034# Air Force Systems Command, Wright-Patterson AFB, Ohio. Flight Dynamics Lab.
THE VIBRATION AND BUCKLING CHARACTERISTICS OF CYLINDRICAL SHELLS UNDER AXIAL LOAD AND EXTERNAL PRESSURE Technical Report, Jun. 1965–Aug. 1966
William F. Bozich May 1967 107 p refs
(AFFDL-TR-67-28; AD-656302)

The Galerkin method is applied to Flugges differential equations for the vibration of a cylindrical shell under axial load and external pressure to obtain a 3N x 3N characteristic equation in matrix form. N is the number of terms in the assumed series of displacement functions for the u, v, and w displacements which can be selected to satisfy various boundary conditions. For the freely-supported cylinder an exact solution exists, and the various assumed modes uncouple, reducing the problem to the solution of a 3 x 3 characteristic equation for each mode. The third order characteristic equation for the freely-supported cylinder was solved for a wide range of shell parameters. The natural vibration frequencies and buckling values for axial load and external pressure for all three eigenvalues associated with each mode, are presented in a series of figures. The square of the vibration frequency for any mode was found to vary linearly with axial load, and approximately linearly with a pressure loading for modes with two or more circumferential waves.
Author (TAB)

N67-37061# Army Natick Labs., Mass. Airdrop Engineering Div.
DESIGN OF CUSHIONING SYSTEMS FOR AIRDROP
Maurice P. Gionfriddo Feb. 1967 36 p refs
(TR-67-59-AD; AD-655280)

Complementary analytical and empirical techniques for the design of energy dissipater configurations for airdropped items are presented. The techniques are applicable to the use of single-shot, sheet-type energy dissipater materials which have an essentially rectangular stress-strain curve for the greatest part of their deformation, such as paper honeycomb, metal honeycombs, and certain foamed plastics.
Author (TAB)

N67-37080# Structural Mechanics Associates, Narberth, Pa.
STRUCTURAL OPTIMIZATION OF FLAT, CORRUGATED CORE AND WEB-CORE SANDWICH PANELS UNDER INPLANE SHEAR LOADS AND COMBINED UNIAXIAL COMPRESSION AND IN-PLANE SHEAR LOADS Final Report, 25 May 1965–31 Dec. 1966
Jack R. Vinson and Sidney Shore Philadelphia, Pa., Naval Air Eng. Center, 1 Jun. 1967 101 p refs
(Contract N156-46654)
(NAEC-ASL-1110; AD-656056)

The report presents the development of rational methods of structural optimization for flat, corrugated core (single truss

core) and web-core sandwich panels under two loading conditions: in-plane shear loads, and combined uniaxial compression and in-plane shear loads. These methods provide a means by which minimum weight structures can be designed for a given load index, plate width, length, and face and core materials. The methods developed can be used as a means of rational material selection by comparing weights of optimum construction for various material systems as a function of applied load index. The methods are sufficiently general to account for orthotropic or isotropic face and core materials and various boundary conditions. Design procedures are given in detail for the design engineer to use. Author (TAB)

N67-37097# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
THE RESPONSE OF A CYLINDRICAL STRUCTURE TO A TURBULENT FLOW FIELD AT SUBCRITICAL REYNOLDS NUMBER
A. C. Campbell and B. Etkin Jul. 1967 60 p refs
(UTIAS-TN-115; AD-656689)

A wind tunnel study was made of the bending moment response of a cylindrical structure exposed to a turbulent wind. A theory, developed by Etkin, of the response of a slender structure in the stream direction to a turbulent wind was compared with the experimental results. The structure used for the study was an approximate aeroelastic model of an existing radio antennas. A turbulence field was generated in the wind tunnel by a square mesh grid. With a ratio of longitudinal turbulence scale to model diameter of $L/D = 21$ and an intensity of 20% the model in this turbulence field was then representative of a full scale structure in atmospheric turbulence. Bending moment spectra in the drag and lift directions were obtained for various turbulence conditions. It was found that close agreement was obtained between theory and experimental results in the turbulence field. This indicates that the drag coefficient for this cylinder is very similar under turbulent and steady wind conditions. Some measurements of lift-drag correlation were also made which indicated that essentially zero correlation exists in the turbulent field. It was concluded that the theory provides a reasonably accurate method of predicting the response of a slender structure to a turbulent wind. Author (TAB)

N67-37101# North American Aviation, Inc., Columbus, Ohio. Columbus Div.
A REDUNDANT-FORCE METHOD FOR THE INELASTIC ANALYSIS OF MECHANICALLY FASTENED JOINTS
R. W. Gehring and C. H. Maines Philadelphia, Pa., Naval Air Eng. Center, 31 Jan. 1967 74 p refs
(Contract N156-45330)
(NAEC-ASL-1103; AD-656057)

An inelastic redundant-force method for the stress and strength analysis of multifastener, multi-plate splice joints is described. The methods predict the allowable ultimate load, as well as the plate element and fastener load distribution at any desired load level. Tapered splices and mixed materials are allowed for and the plates may be discontinuous. Examples are shown for use of the method and application to a full-scale aircraft component major splice joint. The conclusion is that the method gives accurate results for failure prediction including failing load, mode of failure, and failure location. Author (TAB)

N67-37188# Naval Ship Research and Development Center, Washington, D. C.
THE INELASTIC BUCKLING STRENGTH OF FABRICATED HY-80 STEEL HEMISPHERICAL SHELLS
Malcolm G. Costelle and Kanehiro Nishida Apr. 1967 50 p refs
(DTMB-2304; AD-655249)

Eight, 66-in.-diameter, fabricated HY-80 steel hemispherical shells designed to fail by inelastic buckling were tested to observe the effects of initial imperfections and residual stresses on elastic behavior and collapse strength. The results demonstrate that the effect of secondary moments and residual stresses on collapse strength diminish as the ratio of elastic to inelastic buckling pressure increases. It was possible to predict the collapse pressures of these models within +10 or -10 percent by utilizing imperfection analysis and extrapolating previous test results of less stable shells. Fairly good agreement was also obtained by using the same imperfection analysis to predict the membrane stresses in the center of the flat spots. Addition of the results of these tests to those obtained on shells in the less stable regions provides a basis for a reasonable collapse equation for practical spherical shells over the range of shell stability of interest to deep submergence. Author (TAB)

N67-37289# Weidlinger (Paul) Consultants, New York.
BUCKLING OF VESSELS COMPOSED OF COMBINATIONS OF CYLINDRICAL AND SPHERICAL SHELLS
Azriel Harari and Melvin L. Baron Jul. 1967 50 p refs
(Contract Nonr-3454(00) FBM)
(TR-7; AD-656639)

The overall buckling of unstiffened cylindrical shells with hemispherical end caps is studied. Numerical results for the buckling load parameter are obtained in terms of the parameters h/a, L/a and n. The theoretical results are compared with a series of experimental results; excellent agreement between theory and experiment is noted. Author (TAB)

N67-37291# Brown Univ., Providence, R. I. Div. of Engineering.
FINITE DEFLECTIONS OF A SIMPLY SUPPORTED RIGID-PLASTIC CIRCULAR PLATE LOADED DYNAMICALLY
Norman Jones May 1967 30 p refs
(Contract ARPA SD-86)
(ARPA-E42; AD-656731)

A theoretical analysis is presented for the dynamic behavior of a simply supported reigid, perfectly plastic circular plate subjected to a rectangular pressure pulse. It is shown that this theory, which considers the simultaneous influence of membrane forces and bending moments, predicts final deformations which are considerably smaller than those given by the corresponding bending theory of Hopkins and Prager even when maximum deflections only of the order of the plate thickness are permitted. It is believed that this theoretical analysis should assist in the interpretation of the dynamic biaxial stress-strain characteristics of materials recorded on diaphragms fitted in impact tubes and could be developed further in order to describe the behavior of plates having other support conditions and different dynamic loading characteristics. Author (TAB)

N67-37294# Aerospace Corp., El Segundo, Calif. Aerodynamics and Propulsion Research Lab.
DYNAMICS OF A TWO-LAYERED TIMOSHENKO-TYPE CYLINDRICAL SHELL INCLUDING THE EFFECTS OF SHEAR DEFORMATION OF THE INTERLAYER BOND
John P. Jones and James S. Whittier Jun. 1967 41 p refs
(Contract AF 04(695)-1001)
(TR-1001(2240-30)-7; SSD-TR-67-119; AD-656338)

Equations of (axially symmmetric) motion are derived for a cylindrical shell whose two layers are connected by a thin, deformable bond. Effects of shear deformation and rotatory inertia are accounted for in each of the shell layers. A thin, inertialess, interlayer bond that deforms only in shear is assumed. A nondimensional bond stiffness parameter is introduced, and the effect of bond stiffness on the dynamic behavior of the shell is

investigated for the case of axial wave propagation in an infinitely long shell. The bond stiffness parameter has a profound influence on some of the wave propagation frequencies. An expression is given for a critical value of the bond stiffness parameter that separates stiff and soft bonds. For the limiting cases of very stiff or very soft bonds, simplified theoretical approaches give adequate accuracy; however, it appears necessary to use the theory in full for bonds of intermediate thickness. Author (TAB)

N67-37297# Argonne National Lab., Ill.

TRANSIENT THERMAL STRESSES IN HEAT-GENERATING PLATES AND HOLLOW CYLINDERS CAUSED BY SUDDEN CHANGES IN ENVIRONMENTAL TEMPERATURE

R. A. Valentin, G. S. Rosenberg, and D. F. Schoeberle (Ill. Univ., Chicago) Feb. 1967 45 p refs

(Contract W-31-109-ENG-38)

(ANL-7294) CFSTI: HC$3.00/MF$0.65

The transient thermal stresses in a free, heat-generating flat plate and a free, hollow, heat-generating cylinder, insulated at its outer surface and cooled on its inner surface through a temperature-independent boundary conductance, are analyzed within the framework of a quasi-static treatment to determine the effect of a sudden change in environmental temperature when combined with internal heat generation. The flat-plate problem is treated by Laplace transform methods, and the cylinder problem is analyzed by using a recently developed extrusion of the classical Hankel transform. Graphical temperature and stress results are presented for a wide range of Biot numbers and, in the case of the hollow cylinder, for a wide range of the thickness parameter. In addition, an extensive table of the characteristic roots occurring in the definition of the Hankel transform is included since these roots should find many applications beyond the particular cylinder problem considered. Author

N67-37331 Aeronautical Research Council (Gt. Brit.).

SOME THEORETICAL STUDIES CONCERNING OLEO DAMPING CHARACTERISTICS

H. Hall 1967 33 p refs

(ARC-CP-951) HMSO: 6s 6d

Results are presented of a study that has been made to investigate the effect of damping characteristics on the performance of an oleo strut. Conventional oleo struts employ orifice dampers in the interests of providing high energy absorption for the design vertical velocity of descent case. It is shown that an equivalent strut, i.e. one having the same maximum stroke, utilizing a damping mechanism providing a force proportional to the stroking velocity, instead of the square of this velocity, will benefit by a 10% reduction in stress in the design case. Comparison of the performance of these two types of damper in the taxi phase of operation over a real profile shows that a linear damper has better characteristics than an orifice damper having the same damping constant in compression and recoil. Author

N67-37425*# IIT Research Inst., Chicago, Ill. Technology Center.

DESIGN OF STATICALLY DETERMINATE TRUSSES FOR MINIMUM WEIGHT AND DEFLECTION

Ralph L. Barnett May 1967 41 p refs

(Contract NASR-65(16))

(NASA-CR-88552; QR-4) CSCL 20K

The stiffness/weight ratios of statically determinant plane or space trusses are maximized by adjusting their bar areas and by optimizing their configurations. When minimum bar areas are specified together with the outline of a truss, a simple nonlinear programming problem is obtained which yields a global optimum. In the pure deflection problem where minimum bar areas are not assigned, three cases are encountered. In one, no physical solutions exist; in the second, a unique set of bar areas are obtained which represent the absolute minimum weight design for a specified deflection or conversely; and in the last, a degenerate case is obtained in which positive, negative, or zero deflection can be achieved at a node with an infinite number of truss designs of vanishing weight. Under very special circumstances the minimum deflection trusses display uniform stresses. Here, the optimum truss configuration corresponds to a Michell structure designed for equal tensile and compressive stresses. In general, however, the truss outline may be adjusted to produce the degenerate case in which any deflection is obtainable with structures of arbitrarily small weight. Author

N67-37446# California Univ., Livermore. Lawrence Radiation Lab.

THERMALLY GENERATED STRESS WAVES IN A DISPERSIVE ELASTIC ROD

C. Mark Percival (Ph.D. Thesis) 28 Apr. 1967 102 p refs

(Contract W-7405-ENG-48)

(UCRL-50252) CFSTI: HC$3.00/MF$0.65

The propagation of thermally generated stress waves in a dispersive elastic rod is investigated both experimentally and analytically. In the experimental investigation, the end of a circular colored glass rod is heated very rapidly by the deposition of luminous energy from a Q-switched ruby laser. The light from the laser is directed parallel to the axis of the rod and deposited on the polished end of the rod. The absorptivity of the glass for light emitted by the laser is such that the depth of penetration is of the same order as the radius of the rod. The length of the energy pulse from the laser is 20 nsec (i.e., 20×10^{-9} sec). This results in heating at such a rate that it can be considered as instantaneous when compared to the mechanical response of the material used. The resulting stress wave is measured using a thin quartz crystal in a Hopkinson pressure-bar arrangement. Dispersion precludes the use of the simple wave equation, so Love's modified wave equation is used to describe the motion. The thermoelastic problem is reduced to a homogeneous partial differential equation with appropriate initial and boundary conditions, which is solved by the separation of variables technique. The experimental results are in good agreement with the theory. The amplitude of the stress waves was found to be directly proportional to the total energy deposited. The very short stress pulses generated by Q-switched laser deposition on the end of the thin rod gave rise to the higher modes of longitudinal wave propagation. The existence of wave propagation in a thin rod at near dilatational velocities was experimentally confirmed. It is concluded that the experimental techniques developed can be used to model stress wave generation due to electromagnetic energy depositions, and they also provide an efficient means for generating the higher modes of longitudinal wave propagation in thin rods. Author (NSA)

N67-37492* Georgia Inst. of Tech., Atlanta.

HEMISPHERICAL SHELLS SUBJECTED TO DYNAMIC, THERMAL, AND RANDOM LOADINGS

Chi-wen Lin (Ph.D. Thesis) Aug. 1967 138 p refs

(Grants NsG-571; NSF GK-895)

(NASA-CR-88612) CSCL 20K

Closed-form solutions for the axisymmetric dynamic response of hemispherical shells with roller-hinged edges and roller-clamped edges were obtained by using modal analysis. Numerical results for free vibrations and the dynamic response of the shell are discussed in detail. The analysis can also be carried out by applying the mode-acceleration method of Williams. A particular term is added to the formal solution for a problem with external dynamic loading so that the resulting solution in this case satisfies the governing differential equations and boundary conditions. The free vibration of an elastic cylinder with a hemispherical shell bottom, and random excitation of thin elastic shells, were also investigated. L.S.

N67-37499# Naval Ship Research and Development Center, Washington, D. C.
THE TORQUE ON A FINITE DISK EXECUTING DAMPED HARMONIC OSCILLATIONS IN A VISCOUS FLUID NEAR A RIGID BOUNDARY Final Report
Fred C. De Metz (M.S. Thesis—La. State Univ., Baton Rouge) Jun. 1967 54 p refs
(Rept.-2395; AD-655238)

Expressions are derived for the torque exerted on a finite cylindrical disk which executes torsional oscillations about the cylindrical axis while immersed in a viscous fluid parallel to a rigid plane boundary. Relations for the total torque of the fluid are given in terms of the period and decrement of disk oscillation for small, large, and intermediate separation distances between the disk and the rigid plane boundary. Mathematical relations and graphic results are presented in a form intended to aid investigators in studying the properties of fluids flowing in narrow channels. Author (TAB)

N67-37514# University Coll., Cork (Ireland).
THE λ-METHOD FOR BOUNDARY VALUE PROBLEMS Interim Scientific Report
G. V. Kelly and P. M. Quinlan Feb. 1967 167 p refs
(Grant AF EOAR-65-40)
(AFOSR-67-0975; AD-656391)

The lambda-Method is checked against existing solutions for uniformly loaded square and skew plates and methods for accelerating the convergence of the solutions are developed. Symmetrical edge-functions are developed and applied to a regular polygonal plate of 4n sides. A comprehensive treatment is given of skew and rectangular plates supported by flexible beams. The solution in all cases gives an exact solution to the mathematical model, where the calculated boundary residuals replace the specified boundary conditions. A Fortran (1620) Programme is appended for the quadrilateral plate. Author (TAB)

N67-37580# Aerospace Corp., El Segundo, Calif. Aerodynamics and Propulsion Research Lab.
INTERFACE WAVES WITH A FLEXIBLE BOND
John P. Jones and James S. Whittier Oct. 1966 20 p refs
(Contract AF 04(695)-1001)
(TR-1001(2240-30)-2; SSD-TR-66-198; AD-803393) CFSTI: HC $3.00/MF $0.65

Plane strain elastic wave propagation is studied for two dissimilar halfspaces joined together at a plane interface by a thin elastic bond. Attention is focussed on solutions corresponding to the propagation of interface waves along the bond. The existence of interface waves is found to be governed by a parameter involving bond stiffness and wavelength. The limiting case of an infinitely stiff bond corresponds to the interface wave problem first solved by Stoneley and it is shown that the present analysis yields Stoneley's frequency equation in this limit. Also the limiting case of an infinitely soft bond is found as expected to give two Rayleigh surface waves, one in each medium. It is shown analytically that for intermediate bond stiffnesses there may occur zero, one, or two interface waves depending on the properties of the bond and the media. Illustrative numerical examples are presented. It is the conclusion of this study that account must be taken of the stiffness of the bond and the wavelength of the disturbance before it is proper to speak of an interface wave existing or not existing at a bonded interface. Author

N67-37583# California Univ., Berkeley. Structural Engineering Lab.
FINITE ELEMENT ANALYSIS OF AXISYMMETRIC SOLIDS WITH ARBITRARY LOADINGS Interim Technical Report
Robert S. Dunham and Robert E. Nickell (Rohm and Haas Co., Huntsville, Ala.) Jun. 1967 125 p refs
(Contract N123(60530)-55641A)
(SEL-67-6; AD-655253)

The finite element method is applied to solids with an axis of material symmetry subjected to Fourier expandable thermal, body force and surface traction loadings. The governing equations are derived for triangular toroidal continuum elements and for thin conical shell elements. A computer program is described and various results are presented as verification. The program is described and a users manual is given. A listing of the program source deck is included. Author (TAB)

N67-37594# Ohio State Univ. Research Foundation, Columbus.
STRESS AND DEFLECTION ANALYSIS OF FIBROUS COMPOSITE MATERIALS UNDER EXTERNAL LOAD Summary Technical Report No. 1, Oct. 15, 1965–Mar. 15, 1967
William E. Clausen and Arthur W. Leissa Wright-Patterson AFB, Ohio, AF Mater. Lab., Jun. 1967 78 p refs
(Contract AF 33(615)-3298)
(AFML-TR-67-151; AD-656431)

The purpose of the work is to apply the point-matching technique to the stress and deflection analysis of fibrous composite materials; to develop a computer program, based on the method, to solve transverse normal loading problems involving fibers with cross-sections having two axes of symmetry in a staggered array; and to demonstrate the use of the computer program. The separate constituent materials are assumed to be linearly elastic, isotropic, and homogeneous. The bonding between the fiber and matrix materials is assumed to be perfect. The equations of plane strain theory are presented and the Michell solution in polar coordinates is used. The point-matching method is used to satisfy the boundary conditions in the least squares sense at a finite number of discrete points. Author (TAB)

N67-37658* Allied Research Associates, Inc., Concord, Mass.
HYPERVELOCITY IMPACT MECHANICS, BIBLIOGRAPHY AND INDEX Final Technical Report
Robert F. Smiley 30 Jun. 1967 74 p refs
(Contract NASw-1378)
(NASA-CR-88890; ARA-327-8) CSCL 20K

An extensive indexed bibliography is presented, covering primarily the subject of experimental and theoretical information on the mechanics of penetration of structures by hypervelocity projectiles. Also included is a limited coverage of information on the meteoroid environment and on design considerations for the meteoroid hazard. Author

N67-37673*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ANALYSIS OF STRESS-RUPTURE AND CREEP PROPERTIES OF TUNGSTEN-FIBER-REINFORCED COPPER COMPOSITES
David L. McDanels, Robert A. Signorelli, and John W. Weeton Washington, NASA, Sep. 1967 59 p refs
(NASA-TN-D-4173) CFSTI: HC $3.00/MF $0.65 CSCL 11F

An analysis of the creep-deformation behavior of fiber-reinforced metallic composites was developed. Equations for predicting the creep rate and stress-rupture properties of fiber-reinforced metallic composites are presented. Stress-rupture and creep tests were conducted at 1200° and 1500°F on tungsten-fiber-reinforced copper composites. The results of these tests were used to verify the validity of the equations developed in the analysis. A discussion is presented relating the results obtained with the model system to more practical fiber-reinforced composite systems for stress-rupture applications. The stress-rupture strengths obtained with the tungsten-copper model system compared

favorably with those of existing superalloys and demonstrated the potential of fiber-reinforced metallic composites in stress-rupture applications at elevated temperatures. Author

N67-37682*# LTV Aerospace Corp., Dallas, Tex.
FATIGUE BEHAVIOR OF A FUSION WELDED Ti-8Al-1Mo-1V SIMULATED WING STRUCTURE UNDER THE ENVIRONMENT OF A SUPERSONIC TRANSPORT
John J. Peterson Washington, NASA, Sep. 1967 73 p refs
(Contract NAS1-5495)
(NASA-CR-881) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Work was done to supplement information which was generated earlier by testing riveted and spot welded structures. Tests were performed on box beams having tension covers featuring typical skin stringer welded structures. Material used was Ti-8Al-1Mo-1V in the duplex annealed condition. Both constant amplitude and spectrum fatigue tests were conducted. Tests were performed at room temperature and 550°F. Spectrum tests were conducted under conditions which simulated the environment of the SST. Four specimens were fabricated and tested. Author

N67-37711 Joint Publications Research Service, Washington, D. C.
INTERACTION OF SOLIDS COLLIDING AT HIGH SPEEDS
V. S. Lenskiy 12 Sep. 1967 51 p refs Transl. into ENGLISH of the book "Materialy Vsesoyuznogo Simposiuma po Rasprostraneniyu Uprugo-Plasticheskikh Voln v Sploshnykh Sredakh" Baku, 1966 p 26-65
(JPRS-42562; TT-67-33190) CFSTI: $3.00

A survey and general evaluation are presented on material pertaining to the interaction of solids at high velocities, based mainly on data derived from American sources. The characteristics of gas guns used in collision experiments to accelerate massive solids and particles to the required velocities are discussed in detail. Consideration is also given to explosive, fragmentation, and reflection and splitting methods, and to electroexplosive and electrostatic accelerators. Theoretical approaches to constructing equations of state of solids are reviewed, with particular reference to equations for metals and other materials which approximate the pressures and velocities encountered in the interaction of solids at various high speeds. Experimental data are compared with theoretical calculations of the crater formation process, and possible mechanisms of piercing a solid plate are assessed. A source bibliography is included. M.G.J.

N67-37772# Naval Civil Engineering Lab., Port Hueneme, Calif.
DYNAMIC SHEAR RESISTANCE OF THIN-WEBBED REINFORCED CONCRETE BEAMS Technical Report, Dec 1965-Nov. 1966
David S. Fuss Jun. 1967 40 p refs
(R-534; AD-655823)

Experiments were performed to obtain information on the dynamic shear and diagonal tension resistance of reinforced concrete I-beams constructed with welded-wire fabric as web reinforcement. These experiments were in support of the ultimate objective of the project, which is a formulate design criteria for thin-shell concrete structures to withstand dynamic loading such as is produced by the detonation of a nuclear weapon. Under uniformly distributed loads, the dynamic diagonal tension resistance of the beams was found to be significantly greater than the static diagonal tension resistance. The increase in resistance was attributed to the increase in tensile strength of concrete under rapid stressing. The ultimate shear resistance of the beams could not be precisely determined from the tests because only three of the beams failed in shear. However, evidence was found that the dynamic ultimate resistance of such beams is only slightly greater than the static ultimate resistance. Author (TAB)

N67-37780* Astro Research Corp., Santa Barbara, Calif.
INVESTIGATION OF MATERIALS FOR THE LOW FREQUENCY TELESCOPE EXPERIMENT Interim Report
4 Aug. 1967 62 p refs
(Contract NAS7-426)
(NASA-CR-88861) CSCL 13H

Properties and other important characteristics of candidate materials for the LOFT have been extracted from the literature and are presented in individual data sheets. This investigation will continue with further compilation of this information and the development of criteria for selecting from among these materials, as the design of the Low Frequency Telescope progresses. In this report only the reflector net, tensioning tapes and lattice compression column are considered. The influence of the material properties and characteristics on the design is discussed. Author

N67-37786*# Systems Technology, Inc., Hawthorne, Calif.
FOR LARGE HIGHLY COUPLED ELASTIC BOOST VEHICLES Final Report
VEHICLES Final Report
Donald E. Johnston and Walter A. Johnson Mar. 1967 191 p
(Contract NAS8-11419)
(NASA-CR-88780; STI-TR-146-2) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Control of highly-coupled, very large boost vehicles was studied in which elastic and fuel slosh modes had frequencies close to the desired control frequencies. Exact and simplified equations of motion were investigated, including the generation of sensor numerator factors and the comparison of transfer functions. A relatively simple control system was synthesized which uses normal acceleration and attitude rate feedbacks to damp the elastic and rigid body modes throughout the boost phase. Attitude control and load relief modes are closed about the damped vehicle. A sensitivity analysis was made to determine the potential problem areas, and adaptive mechanization considerations are reported. Appendixes deal with the basic vehicle data, the simplified equations of motion, and the sawtooth body concepts. A preliminary analysis via simplified transfer functions and a system synthesis with exact transfer functions are included; and the use of baffles to damp slosh modes is reported. M.W.R.

N67-37803# Brown Univ., Providence, R. I. Div. of Engineering.
DISPLACEMENT BOUNDS FOR DYNAMICALLY LOADED ELASTIC STRUCTURES
John B. Martin Mar. 1967 24 p refs
(Contract N189(181)-60723A(X))
(BU/DTMB/9; TR-9; AD-655924)

A simplified derivation of an earlier result for finding upper bounds on displacements for dynamically loaded elastic structures is presented. The new derivation permits a better physical appreciation of the technique, and shows that in certain cases the method can be extended to cover plates and fixed beams in which membrane forces due to geometry changes occur. Author (TAB)

N67-37882*# Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
A DUAL FINITE ELEMENT COMPUTER SYSTEM FOR STRETCHING AND BENDING OF ORTHOTROPIC PLATES
Dennis Alan Nagy Sep. 1967 209 p refs
(Grant NGR-22-009-059)
(NASA-CR-88866; R76-44) CSCL 20K

The objects of this report are 1) a study of the dual displacement-stress function finite element method in matrix form, with particular consideration of a number of different types of boundary conditions, and 2) implementation of the method as a computer system for the solution of both plate stretching and plate bending problems. The computer system is developed as an addition to the general capabilities of the Finite Element Analyzer, which in turn is a part of the problem oriented Structural Design Language (STRUDL) within the Integrated Civil Engineering System (ICES). The finite element displacement method as applied to stretching of triangular plate elements is presented with particular reference to formulation of the system equations in matrix form. The dual stress function method for bending of triangular plate elements is then presented in light of the displacement method. Specific consideration is given to a number of different types of boundary conditions of the stretching and bending problems and the matrix modifications necessary for the introduction of these conditions to the system of equations. The additional problem oriented language commands added to the Finite Element Analyzer for use in solving dual plate stretching and bending problems are presented in a partial user's manual intended as a supplement to the Finite Element Analyzer User's Manual. The actual programming of the system has been done in Command Definition Language (CDL) and Icetran (ICES–Fortran) as part of ICES. Detailed system documentation (data structure, data COMMON storage, program descriptions, and program listings) is presented in the appendices. The initial implementation of the system is in a limited form, but its flexibility and modularity allow for easy modification and sophistication at a later date. Author

N67-37848# Applied Technology Associates, Inc., Ramsey, N. J.
STRESS SOLUTION FOR AN INFINITE PLATE UNDER EQUAL BI-AXIAL STRESS CONTAINING TWO CIRCULAR HOLES OF UNEQUAL RADII
V. L. Salerno Mar. 1967 50 p refs
(Contract W-7405-ENG-26)
(TID-23783; Rept.-113) CFSTI: HC $3.00/MF $0.65

A method of successive approximations, utilizing analytic stress functions of the complex variable z, in the manner of the Schwartz Alternating Method was used to obtain the solution of the stress distribution around two circular holes of unequal radii in an equal biaxial stress field of an infinite plate. The stress functions up to a third approximation are obtained for the problem and several numerical examples are given which denote the accuracy and degree of convergence of the process. It is believed that this basic solution for two holes may be used to obtain solutions to more complicated hole patterns. Author (NSA)

N67-37868# Illinois Univ., Urbana.
PLASTIC RESPONSE OF SOLIDS
J. J. Gilman 28 Apr. 1967 38 p refs Presented at the Battelle Colloq. on Dislocation Dyn., Seattle–Harrison, 1–6 May 1967
(Contracts AT(11-1)-1198; Nonr-3985(06); DA-ARO(D)-31-124-G873)
(COO-1198-445; CONF-670513-4) CFSTI: HC $3.00/MF $0.65

Past developments of the micro-dynamical description of plastic flow are outlined, and the successes of the theory are mentioned. Some extension in scope are suggested and discussed. These include: application to polymeric solids, collective dislocation behavior, and dynamics of precipitation hardening. The difficulty that the flowing state differs from the post-flowing state is emphasized. It is proposed that dislocation lines exist in non-crystalline solids and provide a convenient description for local shear correlations. The possibility that flutter is induced in moving dislocations by turbulent phonon-gas flow is considered. Finally, an atomic model for dislocation mobility in covalent crystals is presented. Author (NSA)

N67-37869# Bettis Atomic Power Lab., West Mifflin, Pa.
VALIDITY OF THE METHODS OF CALCULATION OF PLATES PERFORATED WITH NUMEROUS HOLES
Tran-Huu-Hanh 1966 40 p refs Transl. into ENGLISH from French
(WAPD-TRANS-55) CFSTI: HC $3.00/MF $0.65

Methods of calculation of the strains and deformations tube plates in heat exchangers and reactors undergo under given loads are examined. The perforated plates can be replaced by a full plate of the same dimensions and two ways of carrying out the transformations are investigated. The method of bonding and deflection coefficients is not very rigorous and does not lead to a precise analysis of strains and deformations. The method of equivalent elastic constants gives only partially satisfactory results. NSA

N67-38034 Adviesbureau der Genie, The Hague (Netherlands).
DETERMINATION OF PEAK PRESSURE AND POSITIVE PHASE DURATION FOR THE MAXIMUM DEVIATION OF AN ELASTIC MASS-SPRING SYSTEM [DE BETEKENIS VAN PIEKDRUK EN POSITIEVE PHASE-DUUR VOOR DE MAXIMUM UITSLAG VAN EEN ELASTISCH MASSAVEERSYSTEEM]
R. W. Trense Jan. 1967 26 p In DUTCH
(Rept.-149; TDCK-48639)

Details of a mathematical analysis are given which employs the Laplace transform and matrix calculations to obtain the solution for this problem and similar elastic systems. Transl. by K.W.

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N67-36717# Purdue Univ., Lafayette, Ind.
ANALYSIS AND EXPERIMENT OF RADIANT HEAT EXCHANGE BETWEEN SIMPLY ARRANGED SURFACES Technical Report, May 1965–Jun. 1967
Raymond Viskanta, James R. Schornhorst, and Jaswant S. Toor Wright-Patterson AFB, Ohio. AF Flight Dyn. Lab., Jun. 1967 131 p refs
(Contract AF 33(615)-2362)
(AFFDL-TR-67-94; AD-655335)

The work reported herein covers the effort to improve the accuracy and to provide some confidence in the analytical methods for predicting radiant heat exchange among surfaces having nonelementary emission and reflection characteristics. The study consisted of an examination of the validity of commonly used simplified methods of radiant heat transfer analysis, measurements of local irradiation at a surface and Monte Carlo calculations to estimate what level of detail is important in the description of the radiation characteristics of surfaces. The radiant heat transfer problem was first formulated for a general enclosure with as few simplifying assumptions as possible and then specialized to a very simple configuration. Solutions for the local radiant heat flux and incident flux were obtained for seven different models approximating the radiation characteristics of surfaces. The local irradiation measurements were made for sandblasted stainless steel, electropolished stainless steel, rough electroplated gold, smooth

electroplated gold, and PV 100 white paint over the temperature range from 50 degrees F to 850 degrees F. The predictions of the local incident flux using the diffuse, specular, and diffuse-specular models have been compared with experimental results. The Monte Carlo results showed that under some conditions the choice of the model for radiation surface characteristics can be very critical for both the local heat transfer and overall radiant interchange calculations. Author (TAB)

N67-38736*# Spectrolab, Inc., Sylmar, Calif.
ANALYTICAL, EXPERIMENTAL, & DEVELOPMENTAL WORK FOR A RADIATIVE HEATING SYSTEM, VOLUME I Final Report
[1967] 237 p
(Contract NAS2-1620)
(NASA-CR-73132; FR-6002, Vol. I) CFSTI: HC $3.00/MF $0.65 CSCL 13A

The optical system concept, and the optical and thermal design development are discussed, and the fabrication and test evaluation of the prototype optical system are reported. Details are presented on the theoretical considerations and the system concept study. Results are given of the analyses of the thermal loading, the field lens and projection lens absorption coefficient, and the estimated operating temperatures of the respective lenses. Spectral distribution requirements are reviewed, and the water cell filter design is described. The vacuum seal design and the various components are covered. Instrumentation for measuring and monitoring the radiation source characteristics and for measuring the output intensity distribution are reported. N.E.N.

N67-38766*# Princeton Univ., N. J. Guggenheim Labs. for the Aerospace Propulsion Sciences.
A PRELIMINARY STUDY OF THE EFFECTS OF VAPORIZATION AND TRANSVERSE OSCILLATIONS ON LIQUID JET BREAKUP
James A. Newman Jul. 1967 121 p refs
(Contract NASr-217)
(NASA-CR-72258; AMS-TR-785) CFSTI: HC $3.00/MF $0.65 CSCL 21B

An investigation of the breakup of a vaporizing jet in a pseudo rocket engine is reported. Jet behavior of water, ethyl alcohol, and Freon 114 was studied under a variety of steady and oscillatory pressures. The acoustic oscillations have a measurable effect only in the laminar capillary jet region. Sonic oscillations were found to accelerate jet breakup in the laminar region, and to be more efficient when the jet diameter is large. The higher the acoustic field intensity, the more severe the effect was noted. Velocity oscillations were more effective than pressure oscillations at low chamber pressure and high vaporization rates. The spinning mode did not enhance jet breakup to a greater extent than the standing mode. Vaporization of the liquid was also found to promote jet breakup. N.E.N.

N67-38785# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
ON THE PROBLEM OF HEAT CONDUCTION IN A CONTINUOUS CYLINDER
S. M. Kotlyar Apr. 1967 15 p refs Transl. into ENGLISH from Ukr. J. Appl. Mech., v. 10, no. 5, 1964
(ARL-67-0068; AD-655371)

The first part of this paper solves the problem of determining the axially symmetric, steady state temperature field T (r,z) in an infinite homogeneous and isotropic cylinder o < or = r < or = R, - infinity < Z < + infinity provided that there is thermal contact with a medium at prescribed temperature T sub zero (z) over the part r = R, zero temperature over the remaining part of the surface. The solution is obtained in the form of a Bessel-Fourier integral involving an auxiliary function which satisfied a Fredholm integral equation of the second kind. The following part of the paper deals with the analogous question for a finite circular cylinder. This solution appears in the form of a Bessel-Fourier series with an auxiliary function satisfying a Fredholm integral equation of the second kind. Author (TAB)

N67-38789# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
THE FLOW FIELD AND HEAT TRANSFER DOWNSTREAM OF A REARWARD FACING STEP IN SUPERSONIC FLOW
Howard E. Smith (Dayton Univ., Ohio.) Mar. 1967 93 p refs
(ARL-67-0056; AD-655370)

An experimental investigation of the flow field, and the model pressure and steady-state heat transfer distributions for a rearward-facing step in supersonic flow is described. Tests were conducted using a water-cooled model with a step height adjustable to 0.443 and 0.750 inches at free stream Mach numbers of 2.5, 3.5, and 5.0, and at Reynolds numbers based on length of surface ahead of separation of approximately 250,000 to 1,800,000. It was found that the Reynolds number based on step height is an important parameter and that both the base pressure and the maximum heat transfer at reattachment may be predicted as a function of this parameter. Several representative flow fields are presented along with analyses of the various regions of these fields. It was found that the depressed base pressure is communicated upstream of the step through the subsonic portion of the attached boundary layer resulting in a pressure gradient immediately upstream of the step. It is shown that the rapid corner expansion is not the commonly used Prandtl-Meyer expansion, but rather is accurately described by the method of inviscid rotational characteristics which accounts for both the entropy gradient in the boundary layer and the pressure gradient upstream of the step. This description of the corner expansion also accurately predicts the position of the lip shock associated with the rapid expansion. Author (TAB)

N67-38813# Catholic Univ. of America, Washington, D. C. Dept. of Physics.
A STUDY OF LINE SHAPE FOR CO INFRARED EMISSION LINES Final Report, 1 Jan. 1964–31 Mar. 1967
William S. Benedict, James A. Dowling, Jarus W. Quinn, and Shirleigh Silverman 30 Jun. 1967 135 p refs
(Contract AF 19(628)-3870)
(AFCRL-67-0438; AD-656779)

The shape of several vibration-rotation lines of CO emitted by a C2H2-O2 flame was investigated. An equivalent width measurement was made using an absorption cell of room temperature CO as an analyzer. Analysis of the data showed that line shapes could be fitted to a voigt function with shape parameters between 1.0 and 1.5. A computer program was formulated to calculate integrated emissivities with a voigt function line shape. The collision widths of the flame lines, as determined by the shape parameters, are in essential agreement with earlier room temperature measurements. The extrapolation of the widths measured at room temperature to high temperature was shown to be reliable within the accuracy of this experiment. Author (TAB)

N67-38815*# Little (Arthur D.), Inc., Cambridge, Mass.
SOLID PROPELLANT IGNITION BY CONVECTIVE HEATING Final Report
E. Karl Bastress and Walter R. Niesson Oct. 1966 81 p refs
(Contract AF 49(638)-1120)
(AFOSR-67-0932; Rept.-64801-1; AD-655783)

The objective of the study was to determine the effects of gas flow characteristics on solid propellant ignition behavior under con-

vective heating. Ignition tests of three composite propellants were conducted in a hot-gas tunnel designed for convective heating experiments. Effects of gas velocity, test chamber configuration, and approach surface material on ignition were observed. It is concluded that ignition is initiated in the gas phase and is influenced by the local temperature and the local concentration of oxidizer decomposition products from upstream portions of the propellant surface. Either temperature or oxidizer concentration may control the time of ignition. When oxidizer concentration is controlling, the test configuration and gas velocity are important parameters. When temperature is controlling, ignition time can be correlated with heating rate alone. However, long propellant samples must be used to obtain meaningful data. Ignition times measured with long propellant samples are considerably lower than those measured with small samples. Author (TAB)

N67-36837*# California Univ., Berkeley. College of Engineering.
BREAKDOWN OF A LIQUID FILAMENT INTO DROPS UNDER THE ACTION OF ACOUSTIC DISTURBANCES
Robert Henry Wickemeyer and A. K. Oppenheim Jun. 1967 48 p refs
(Grant NSG-702)
(NASA-CR-88365; AS-67-6; TN-1-67) CFSTI: HC $3.00/MF $0.65 CSCL 21B

A theory is presented to determine critical frequencies of a liquid filament as a function of fluid viscosity surface tension and density as well as initial jet diameter and velocity. Experimental results indicated that for a fixed set of jet and fluid properties, there was a spread of critical frequencies which generated uniform drops, rather than a unique frequency as predicted. While the theory did predict a proper functional dependence on Reynolds number for a filament no longer governed by gravitational effects ($Re > 500$) but not yet turbulent ($Re < 2000$), it did not bring out a significant dependence of initial jet diameter. Experimental results for a given fluid, however, were also rendered independent of initial jet diameter. It was found that the smallest drop sizes capable of being produced by capillary instability were 1.8 times initial jet diameters, and thus the practical limit of this method would be 200 micron drops. The ultrasonic devices investigated thus far have not generated a sufficiently uniform flow field for combustion experiments, although they are well capable of producing drops of 10 to 50 microns. Author

N67-36888 General Electric Co., Philadelphia, Pa. Missile and Space Div.
ANALYTICAL DETERMINATION OF THE EFFECTIVE RADIATIVE PROPERTIES OF A SHUTTER TYPE TEMPERATURE CONTROL SYSTEM
E. C. Conway and R. W. Berman 15 Sep. 1965 47 p refs
(Rept.-65SD329)

A radiosity technique to analytically determine the effective radiative properties of a shutter system under the influence of incident solar energy is described. Results are presented for a diffuse radiating surface and combination of diffuse and specular blade surface. A brief description of the computer program used to obtain the results is also given. Author

N67-36903# LTV Aerospace Corp., Dallas, Tex. Vought Aeronautics Div.
INVESTIGATION OF ABLATION EFFECTS ON HYPERSONIC DYNAMIC STABILITY OF A 10° CONE Final Report, Jun. 1966–Nov. 1966
Dave R. Moore, Charles J. Stalmach, Jr., and Thomas C. Pope Wright-Patterson AFB, Ohio, AF Flight Dyn. Lab., Jan. 1967 71 p refs
(Contract AF 33(615)-2902)
(AFFDL-TR-66-230; AD-656492)

An experimental program has been conducted in the LTV Hypervelocity Wind Tunnel at $M = 17$ to investigate the effects of ablation product characteristics and thermal lags on re-entry vehicle dynamic stability. The free oscillation method of dynamic stability measurement was used and the ablation processes were simulated by the controlled mass injection through four sections of the porous model skin. The flow rates through the top and bottom quadrants were oscillated at the same frequency and at an amplitude proportional to the model motion. The thermal lag effect was investigated with nitrogen injection into nitrogen tunnel flow at several different mass flow rates and phase angles between the oscillating mass flow and the body motion. The ablation product study was conducted by injecting gases other than nitrogen with specific heat ratio and molecular weight being the test parameters in addition to mass flow rate. The results obtained from these tests indicate significant effect on dynamic stability with both injection phase angle and some characteristics of the injected gas. The effects of model frequency, Reynolds number and mass injection distribution were also investigated and some static pressure measurements were made near the aft of the model. Appendices to the report contain tabulations of the pertinent data and discussions of supporting analytical studies and data analysis. Author (TAB)

N67-36904# Denver Research Inst., Colo.
EVALUATION OF PROCESSES OCCURRING IN PYROTECHNIC FLAMES Final Progress Report, Feb. 1966–Feb. 1967
Robert M. Blunt 15 Mar. 1967 84 p refs
(Contract N164-11171)
(DRI-880-6703-F; RDTR-91; AD-655820)

Spectroscopic studies of the radiation emitted in the visible region by pyrotechnic compositions containing magnesium and calcium as fuels were made. The species present were identified and data on the dominant wavelength and purity of the radiation from the flames are presented. Spectroscopic techniques which were used to determine the flame temperatures did not produce useful results. The reason for the sodium continuum is discussed and it is compared to the continuum found in the radiation from high pressure mercury discharge tubes. A resume of the important papers published since about 1900 on sodium spectra is given. A bibliography of these papers is provided. The change in the intensity of the visible radiation from magnesium-sodium nitrate flares is compared with the change for calcium-calcium nitrate and magnesium-calcium nitrate as the ambient pressure is reduced. It was noted that anhydrous calcium nitrate can be mixed with calcium metal and pressed into flare candles, but the hydrated nitrate cannot be used satisfactorily. A red shift in dominant wavelength which is associated with increased magnesium content was noted and partially explained. Author (TAB)

N67-36959# Institut za Nuklearne Nauke (Boris Kidric), Belgrade (Yugoslavia).
THERMODYNAMIC CHARACTERISTICS OF SELF-DIFFUSION IN α-URANIUM
Danica Cerovic, Aleksandar Mihajlovic, and Momcilo M. Ristic In its Bull. of the Boris Kidric Inst. of Nucl. Sci., Vol. 17, No. 2 1966 p 145–147 refs (See N67-36954 22-34)

Experimental data were applied to the problem of calculating the changes of the thermodynamic properties of activation in the 450° to 600° C range. Critical consideration was then given to the use of the empirical formula in calculating the activation energy

for self-diffusion in α-uranium. The tabulated data are compared. The results indicate that, with reference to the values of free energy of activation and the entropy of the activation, the equation cannot be used for calculating the activation energy of self-diffusion.
M.G.J.

N67-36960# Institut za Nuklearne Nauke (Boris Kidric), Belgrade (Yugoslavia).
THERMODYNAMIC ASPECTS OF B. PINES SINTERING KINETICS
Vojin Mikijelj and Momcilo M. Ristic *In its* Bull. of the Boris Kidric Inst. of Nucl. Sci., Vol. 17, No. 2 1966 p 148-151 refs
(See N67-36954 22-34)

A thermodynamic analysis is presented on sintering processes, based on the theory of absolute reaction rates and an equation derived to characterize the process in which it is assumed that the sintering is a result of the diffusion process. The interdependence between the sintering rate constant and the surface energy during sintering is defined. It is shown that the free energy change of activation during sintering is directly dependent on the surface energy of the sintering materials.
M.G.J.

N67-37062# Astrosystems International, Inc., Rockaway, N. J.
COMBUSTION GAS EMITTED RADIATION AND CHEMILUMINESCENCE PHENOMENA IN SOLID-GAS REACTING SYSTEMS
John S. Gordon 21 Apr. 1967 23 p refs
(Contract AF 49(638)-1720)
(AFOSR-67-1795; TR-66001-F; AD-656426)

The study was concerned with emission spectra of flames and combustion gases at low pressure of premixed oxygen-hydrogen-ethylene with various solid fuels (plastics), with applications to chemiluminescence, kinetics and reaction mechanism elucidation. Premixed O2-C2H4-PH3 flames were also studied. Attempts to combust plastic samples with oxidizers directly at low pressure without a stable gaseous fuel-oxidizer flame were unsuccessful. Spectral scans coupled with thermochemical analyses indicated several bimolecular reaction mechanisms forming excited species at low pressure with characteristic signatures: CH + N to CN* + H; N + O to NO((2)pi) to NO*; CH + CH to C2* + H2; C + HO2 to CO* + OH; C2 + ClO to CCl* + CO; CCl + OH to CO* + HCl. In addition, emission bands from C3, NH, OH, CH, PO and a continuum possibly due to PO2 were seen.
Author (TAB)

N67-37110# Los Alamos Scientific Lab., N. Mex.
THE EFFECT OF SELF-INDUCED THERMAL-ACOUSTIC OSCILLATIONS ON HEAT TRANSFER TO HYDROGEN
Rodney S. Thurston Dec. 1966 36 p refs
(Contract W-7405-ENG-36)
(LA-3616) CFSTI: HC $3.00/MF $0.65

The effect of self-induced thermal-acoustic oscillations on heat transfer to hydrogen in a 0.25-in. ID by 10-ft-long electrically heated stainless steel tube was studied. Pressures were varied from a subcritical 112 psia to a supercritical 265 psia. Two acoustic modes were observed. One, the first harmonic of standing waves in a pipe open at both ends, occurred at frequencies between 70 and 150 cps and was recorded only for pressure. The second was Helmholtz resonance, which is the acoustic analogy to a spring-mass system. Helmholtz oscillations were observed between 4 and 34 cps on records of pressure, temperature, and flow rate. The maximum Helmholtz-mode pressure amplitude was 34 psi peak to peak, and the maximum fluid temperature amplitude was 100°R peak to peak. Heat transfer to gaseous hydrogen was not affected by axially oriented Helmholtz-mode oscillations with long wavelengths relative to the length of the test section. Heat transfer to two-phase and supercritical hydrogen was influenced by the generation of thermal-acoustic oscillations. Heat transfer improved as the inception of oscillations was approached, but once oscillations occurred, increasing the intensity did not improve the transfer.
Author (NSA)

N67-37176# Aeronautical Research Associates of Princeton, Inc., N. J.
A STUDY OF THE MEAN AND TURBULENT STRUCTURE OF A FREE JET AND JET IMPINGEMENT HEAT TRANSFER
Coleman duP. Donaldson, Richard S. Snedeker, and David P. Margolis Dec. 1966 86 p refs
(Contract Nonr-3903(00)(X); ARPA Order 149-60)
(ARAP-96; AD-656592)

The results of an experimental study of the heat transfer below normally impinging jets are presented. These results are correlated on the basis of the local mean flow and turbulent characteristics of the free jet that would exist in the plane of impingement were this plane to be removed. In order to make these local correlations possible, a rather extensive survey of the turbulent characteristics of the free jet used in the experiments is made that can be used in connection with previous studies of the local mean character of the jet. On the basis of the method of local correlations which is developed, a rationale for computing heat transfer distributions below impinging jets is suggested.
Author (TAB)

N67-37183# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
CALCULATION OF SKIN FRICTION AND HEAT TRANSFER GENERATED BY LM REACTION CONTROL JET IMPINGEMENT ON APOLLO TELESCOPE MOUNT
D. Weiss Sep. 1967 15 p refs
(RM-375)

An analysis is presented of the skin-friction drag generated on a proposed deflector plate so located as to avoid impingement of hot RCS exhaust gases on the Apollo Telescope Mount solar panels. Results indicate that the skin-friction drag is insignificant. Heat transfer values, a by-product of the calculations, are presented for future reference.
Author

N67-37212* Arizona State Univ., Tempe. Dept. of Mechanical Engineering.
HEAT TRANSFER BETWEEN SURFACES IN CONTACT: THE EFFECT OF LOW CONDUCTANCE INTERSTITIAL MATERIALS. PART I: EXPERIMENTAL VERIFICATION OF NASA TEST APPARATUS
P. A. Smuda, L. S. Fletcher, and D. A. Gyorog Jun. 1967 112 p refs
(Grant NGR-03-001-003)
(NASA-CR-73122; ME-TR-033-1) CSCL 20M

Literature on thermal conductance of metallic contacts with interstitial fillers in various environments is reviewed. The test apparatus, which contained a vacuum chamber, was designed with the aim of subjecting the test samples to various environments and physical conditions while obtaining accurate measurements. Tests were carried out with iron and aluminum specimens in contact in a vacuum environment. The test results were used to refine the test section configuration and to set up operating procedures for the apparatus. The final test section configuration consisted of the instrumented test specimens, the fluid cooled sink, the band heater source, an axial insulator, an axial guard heater, and radiation shields. The band heater was insulated with glass wool and covered with aluminum foil. The apparatus and techniques used are considered satisfactory for the investigation of thermal contact conductance with interstitial materials. Test apparatus drawings,

calibration data, uncertainty analysis, and thermal conductivity measurements are included. E.C.

N67-37222*# Lockheed-California Co., Burbank.
A TRANSIENT HEAT TRANSFER AND THERMODYNAMIC ANALYSIS OF THE APOLLO SERVICE MODULE PROPULSION SYSTEM Summary Report
4 Aug. 1965 15 p
(Contract NAS9-3349)
(NASA-CR-65579; LR-18900) CSCL 20M

A detailed thermal analysis of the propulsion system and its components is reported. Earth suborbital, earth orbital, and lunar orbital rendezvous missions were considered. Ascent heating and orientations providing maximum and minimum heating from external sources were included. It was found that the fuel cells are a significant heat source and are largely responsible for thermal problems. Internal, external, and combined internal and external heat transfer were studied. Experimental models were tested in simulated environments to check the analytical procedures, and the experimental and analytical data are summarized. It is felt that the service module propulsion system is basically sound. N.E.N.

N67-37263* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A GENERAL PROGRAM FOR THE CALCULATION OF RADIATION FROM AN INHOMOGENEOUS, NONISOBARIC, NONISOTHERMAL ROCKET EXHAUST PLUME
Robert M. Huffaker and Marcus J. Dash 19 Jun. 1967 140 p refs
(NASA-TM-X-53622) CSCL 20M

Described is a computer program for evaluating radiation from an axisymmetric gas body with water vapor, carbon dioxide, carbon monoxide, and solid carbon particles as radiating constituents, and hydrogen as a non-radiating constituent. The program uses band averaged absorption coefficients with the Curtis–Godson method of approximating inhomogeneous gas properties. This program provides a convenient method of evaluating a great many problems of radiation from rocket exhaust plumes, but available theory is somewhat limited by simplifications in the geometry and input of the program. A more advanced program is being formulated to remove these restrictions. Author

N67-37285# Stevens Inst. of Tech., Hoboken, N. J. Dept. of Mechanical Engineering.
THE COMBUSTION OF POROUS ALUMINUM PLUGS WITH OXYGEN THROUGHPUT
Robert F. Mc Alevy, III, Suh Y. Lee, and Robert P. Wilson, Jr. Jul. 1967 20 p refs
(Contract Nonr-263(48))
(ME-RT-67007; AD-656782)

Combustion of aluminum with oxygen was experimentally studied in the porous-plug configuration. Porous aluminum plugs of different internal structures and void contents were burned at atmospheric pressure with O2 passed up through the specimens to emerge at the burning surface. Burning was achieved for an overall fuel-oxidant equivalence ratio variation of a factor of 4; burning surface regression rates approach 1 inch per second. Periodic accumulation and ejection of burning surface material at low O2 throughout levels appears similar to that exhibited by some aluminized solid propellant and hybrid propellant rocket motors. The results indicate that a porous-metal hybrid approach represents possibly the best means of achieving the ultimate performance potential of a chemical rocket motor. Author (TAB)

N67-37295# Argonne National Lab., Ill.
HEAT TRANSFER FROM A SPHERE TO LIQUID SODIUM DURING FORCED CONVECTION
Larry C. Witte (Ph.D. Thesis—Okla. State Univ.) Jan. 1967 99 p refs
(Contract W-31-109-ENG-38)
(ANL-7296) CFSTI: HC $3.00/MF $0.65

Heat transfer rates from 1/2-in.-dia tantalum spheres to liquid sodium were measured as the spheres moved through a sodium pool. The experimental data were obtained by a transient technique. These experimentally obtained heat transfer rates are compared to theoretically obtained heat transfer rates. By assuming that no vapor is formed at the sphere surface and that superheating of liquid sodium near the surface may occur, a theory is developed to show that large amounts of subcooling in the liquid and motion of the sphere prevent the formation of vapor at the surface of high-temperature spheres. The film-boiling theory which predicts extremely thin vapor films is also developed. The experimental data are correlated with sphere velocity and bulk sodium temperature. Author (NSA)

N67-37318*# Pratt and Whitney Aircraft, East Hartford, Conn.
DETERMINATION OF THE EMISSIVITY OF MATERIALS Semiannual Progress Report, Nov. 15, 1966–May 14, 1967
W. J. Walek, W. L. Luoma, and R. C. Emanuelson 20 Jun. 1967 58 p refs
(Contract NAS3-4174)
(NASA-CR-72294; PWA-3129) CFSTI: HC $3.00/MF $0.65
CSCL 20M

The long-term total hemispherical emittance testing of two AISI-310 stainless steel tubes coated with calcium titanate and iron titanate was completed. Both specimens were vacuum tested at 1350°F. The calcium-titanate-coated specimen demonstrated an emittance which decreased gradually from 0.91 to 0.88. The coating remained seems of both sigma and carbide phases and was slightly harder after testing. No significant interdiffusion of the coating and substrate constituents occurred. The emittance of the iron-titanate-coated specimen remained constant, with only a slight decrease from 0.89 to 0.87. The coating separated from the substrate at the ends of the specimen and around the black-body holes, but the area affected was small, and no significant change in the emittance was observed. Testing also resulted in a partial decomposition of the iron titanate into titanium oxide and ferrous oxide. No significant interdiffusion of coating and substrate consitutents occurred. A 5,000-hour cycling test of an iron titanate-coated columbium-1 percent zirconium tube was completed. A 1500 to 1900°F cycling test of an iron titanate-coated columbium-1 percent zirconium tube was continued. Author

N67-37372# TRG, Inc., Melville, N. Y.
SPACE-TIME CORRELATIONS OF VELOCITY AND PRESSURE AND THE ROLE OF CONVECTION FOR HOMOGENEOUS TURBULENCE IN THE UNIVERSAL RANGE
David M. Chase Apr. 1967 131 p refs
(Contract Nonr-4385(00))
(TRG-011-TN-67-1; AD-655841) CFSTI: HC $3.00/MF $0.65

Kolmogorovs principles provide a basis for the treatment of Eulerian space-time correlations for turbulence in the universal range by explicit separation of the kinematic effect of convection by the large eddies. With reference to unsheared homogeneous turbulence, the usual similarity forms are assumed for intrinsic velocity correlations in a local co-moving frame. The local-convection approximation, neglecting dispersion in this frame and hence relating space-time correlations to pure spatial correlations, is indicated to be a useful one in the inertial and viscous subranges. For an isotropic normal velocity distribution, the structure functions of fluctuating velocity are computed and found to be nearly space-time isotropic in the former subrange and exactly so in the latter. Author (TAB)

N67-37375# Ohio State Univ. Research Foundation, Columbus.
AN INTERFEROMETRIC STUDY OF THE EFFECTS OF CORONA DISCHARGE ON THE TEMPERATURE PROFILES ON A FLAT, UNIFORM TEMPERATURE PLATE IN FORCED CONVECTION
Richard D. Godfrey and Henry R. Velkoff Jun. 1967 131 p refs
(Contract DA-31-124-ARO(D)-246)
(AROD-4942.5-E; TR-4; AD-656466)

The purpose of this thesis was to study the effects of corona discharge on flow past a flat plate at zero incidence. In a previous exploratory investigation into the effects of ionization on the gas in channel flow, interesting results were observed. Pressure drops and heat transfer coefficients were found to double. The velocity profile was distorted. In an attempt to explain the phenomenon, Velkoff hypothesized an induced electric field component in opposition to the flow. An analytical solution for laminar flow with a uniform charge density in the boundary layer was developed by extending the Rossow solution for MHD flows. The corona effect was predicted to retard the flow and thicken the boundary layer. An experimental program was initiated to study this phenomenon by observing changes in the temperature profiles on a flat, uniform temperature plate in forced convection with a Mach-Zender interferometer. A series of tests were run with a constant plate to ambient temperature difference but different free stream velocities and corona currents. At a 62.5 foot per second free stream velocity, a 1000 microns ampere corona current did not effect the flow. At lower velocities, the effects observed were opposite to those predicted. It was found that the boundary layer was turbulent at the 62.5 foot per second test. Also it was noted that 5.9 foot per second test with corona discharge was similar to the 62.5 foot per second test. The body force hypothesized by Velkoff does not appear to describe the corona effect. A possible mechanism that would account for the observed result is that the corona discharge induces an instability in the flow. Author (TAB)

N67-37388 Oregon State Univ., Corvallis. Engineering Experiment Station.
TABLES OF SIMILAR SOLUTIONS TO THE EQUATIONS OF MOMENTUM, HEAT AND MASS TRANSFER IN LAMINAR BOUNDARY LAYER FLOW
E. Elzy and R. M. Sisson Feb. 1967 339 p refs *Its* Bull. no. 40

Dimensionless velocity and profile gradients are tabulated to present similar solutions for the equations of momentum, heat, and mass transfer in laminar boundary layer flow. These tables cover the case where there is no normal velocity at the wall; as well as for profiles when the Prandtl or Schmidt numbers are from 0.0001 to 0.0007, 0.001 to 0.007, 0.01 to 0.09, 0.1 to 0.9, 1.0 to 9.0, 10.0 to 80.0, and 100 to 1000. A discussion of the similar boundary layer equations, transfer coefficients, numerical methods, and accuracy of the calculations is included. M.W.R.

N67-37394# Thiokol Chemical Corp., Denville, N. J. Reaction Motors Div.
BEHAVIOR OF ULTRA-SMALL COLLOID PARTICLES Annual Report, 1 Jan.–31 Dec. 1966
Ronald Caruso Jun. 1967 45 p refs
(Contract AF 49(638)-1675)
(AFOSR-67-0933; AD-655906)

The program is an investigation of the growth and agglomeration behavior of ultra-small metal oxide particles such as Al2O3 or BeO particles which are 10 to 10,000A in diameter. Initial work on this program was oriented toward Al2O3 particles. A premixed flat flame at low sub-atmospheric pressures (2-16 torr) was examined as a technique for generating a cloud of Al2O3 particles. Al(CH3)3 and O2 or air were used. Electron microscopy indicated the formation of 50 and 100A diameter particles in the O2 and air systems, respectively. Extinction and scattering techniques for measuring size and concentration in situ in the particle cloud were unsuccessful because the cloud was optically very thin at such low pressures. Particle and gas temperatures were measured by radiation and reversal techniques and were both about 2300K in the second reaction zone, indicating no hot particle-cool vapor problem. Absolute intensity measurements of the continuum radiation being emitted from the hot particles in the burned-gas zone indicated that no growth of the particles was occurring in the burned-gas zone. The measured absorption coefficient of the molten aluminum oxide, 30/mm at 1.5 microns, is comparable to that observed for molten sapphire. Author (TAB)

N67-37416# Bureau of Mines, Pittsburgh, Pa. Explosives Research Center.
RESEARCH AND TECHNOLOGIC WORK ON EXPLOSIVES, EXPLOSIONS, AND FLAMES, Fiscal Year 1966
Sep. 1967 27 p refs
(BM-IC-8349)

Summaries of research projects and abstracts of publications are presented. Thirteen summaries of research cover the field of explosion, flame, and combustion, including flame characteristics, ignition and detonation, characteristics of fuels and propellants, and fire and explosion safety. Fifteen articles are concerned with explosives research and evaluation, including detonation initiation, propellant and fuel sensitivities, explosive energy transfer, hazards of coal dust and chemicals, and explosive characteristics of liquids and solids. The 18 abstracts of published works cover coal dust and methane hazards, uncontrolled fires, hazards at temperature and pressure extremes, nitroglycerin detonation in rock, and testing of explosives. K.W.

N67-37420# Oak Ridge National Lab., Tenn.
THERMAL CONDUCTIVITY MEASUREMENTS ON SOLIDS BETWEEN 20 AND 150°C USING A COMPARATIVE-LONGITUDINAL APPARATUS: RESULTS ON MgO, BeO, ThO_2, $Th_xU_{1-x}O_{2+y}$ AND Al–UO_2 CERMETS
J. P. Moore, T. G. Kollie, R. S. Graves, and D. L. McElroy Jun. 1967 44 p refs
(Contract W-7405-ENG-26)
(ORNL-4121) CFSTI: HC$3.00/MF$0.65

A comparative-longitudinal apparatus that can be used to measure the thermal conductivity of small uninstrumented specimens from room temperature to 150°C is described in detail. An error analysis is presented which indicates a measurement uncertainty of from ±2 to ±3%. In foils were selected to decrease the interfacial thermal resistance between the specimen and the meter bars. It was found that the interfacial resistance with In foils decreased with increasing pressure in the range from 70 to 5000 psi and was independent of temperature from 20 to 130°C. Thermal conductivity measurements were made on MgO, sol–gel ThO_2, and oxalate–ThO_2 specimens for a variety of densities, and the results compared to the equation, $K_m/K_{T.D.} = (1-\rho')/(1+\beta\rho')$, where K_m is the measured thermal conductivity, $K_{T.D.}$ is the thermal conductivity of theoretically dense material, and ρ' is the pore volume fraction. Experimental values of β obtained for MgO, solgel thoria, and oxalate ThO_2 were 1, 6.5, and 1.2, respectively. Thermal conductivity measurements on $Th_xU_{1-x}O_{2+y}$ with values for (1–x) of 0.047, 0.061, and 0.063 indicated a conductivity nearly as high as pure ThO_2 when the specimens were sintered in hydrogen (y≅0.0) but about one-half that of thoria when sintered in air (y≈0.03). The effects of neutron irradiation on the thermal conductivity of BeO are described. Results on a series of cermets consisting of Al and UO_2 are compared to an expression derived by Eucken for the thermal conductivity of two-phase material. Author (NSA)

N67-37424# National Bureau of Standards, Washington, D. C.
CALCULATION OF THE HEATING VALUE OF A SAMPLE OF HIGH PURITY METHANE FOR USE AS A REFERENCE MATERIAL
George T. Armstrong 15 Dec. 1966 23 p refs
(NBS-TN-299) GPO: $0.25

The heat of combustion of CH_4 has been recalculated in kJ $(mol)^{-1}$ Btu $(mol)^{-1}$, Btu $(cu\ ft)^{-1}$ (dry basis) and Btu (std. cu ft)$^{-1}$ (saturated basis), using the best available experimental determinations of the heat of combustion and other measured quantities and the most recent generally accepted physical constants and defined physical units. The calculations are outlined in detail. The resulting quantities are applied to calculation of the heat of combustion of a reference sample of CH_4 submitted for analysis of composition and certification of heating value by the Institute of Gas Technology. Author

N67-37457# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
ON THE SOLUTION OF EQUATIONS OF TRANSFER FOR A GREY GAS ENCLOSED BETWEEN TWO PLANE SURFACES
Prem K. Khosla Jun. 1967 18 p refs
(Contract Nonr-839(34))
(PIBAL-1024; AD-656576)

A moment method adapted to the boundary conditions of the problem of radiative equilibrium of a grey gas enclosed between two parallel black surfaces is given. Radiative flux as a function of optical thickness based on the distance between the two surfaces and the temperature distribution are evaluated. The method is in the spirit of the generalization of the Milne-Eddington approximation. Author (TAB)

N67-37531# General Electric Co., Philadelphia, Pa.
MATERIAL EFFECTS OF LOW TEMPERATURE ABLATORS ON HYPERSONIC WAKE PROPERTIES OF SLENDER BODIES
J. Cresswell, B. Kaplan, R. Porter, and C. Sarkos *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 2 May 1967 62 p refs (See N67-37521 22-12)

Theoretical computations are presented on the flow field properties in the nonequilibrium boundary layer and wake of a slender conical body for both epoxy and Teflon ablation materials. The calculations were made for two altitudes, differing in ambient density level by an order of magnitude. For the higher density, epoxy is studied in the absence of alkali metal to examine chemi-ionization free of major competing ionization mechanisms. Finite-difference numerical solutions are used to assess the importance of various thermal and chemical effects; emphasis is placed on the altitude-dependent influences exerted upon electron generation and disappearance. Hydrocarbon chemi-ionization and electron attachment to fluorine atoms are also considered. In general, it was found that the physical and chemical characteristics of low-temperature ablators affect the aerothermochemical properties of hypersonic boundary layer and wake flows, and that these causal mechanisms show appreciable sensitivity to the imposed density level (altitude). M.G.J.

N67-37532*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
MEASURED AND PREDICTED ABLATION-PRODUCT RADIATION IN THE NEAR WAKE
Jack D. Stephenson *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 2 May 1967 44 p refs (See N67-37521 22-12)
CSCL 20M

Experiments were conducted in a ballistic range with a counter-current shock-heated airstream, in which spherically blunted models, 1.3 cm in diameter, were fired through air or nitrogen at speeds of ≈7.5 km per sec. The radiation from the near wake was resolved spectrally in the wavelength interval from 0.3 μ to 0.64 μ with two photographic prism spectrographs and spatially with a set of bandpass radiometers, which cover a spectral range from 0.2 μ to 1.2 μ. The radiometer bandwidths vary from about 250 Å in the ultraviolet to 900 Å and 500 Å, respectively, in the visible infrared. During the tests the models attain essentially steady-state ablation before reaching the station where the radiation measurements are made. Author

N67-37534# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
BOUNDARY-LAYER PHENOMENA OBSERVED ON THE ABLATED SURFACES OF CONES RECOVERED AFTER FLIGHTS AT SPEEDS UP TO 7 km/sec
Thomas N. Canning, Max E. Wilkins, and Michael E. Tauber *In* AGARD Fluid Phys. of Hypersonic Wakes, Vol. 2 May 1967 47 p refs (See N67-37521 22-12)

Ballistic range tests were conducted to determine the extent of laminar flow which may be attainable on ablating cones. The experiments consisted of free flights of 1 cm diameter 30° half-angle plastic cones in air at velocities up to 7 km/sec and maximum local Reynolds numbers from 3 to 12 million. The ballistic range was long enough to allow the models to decelerate aerodynamically to low speeds and to be recovered intact. Microscopic examination of the surfaces of recovered models showed several interesting patterns depending on the type of boundary-layer flow experienced. In addition to the surface features observed, the mass ablated was measured and compared to predictions for fully-laminar and fully-turbulent boundary layer flow. At local Reynolds numbers below 5 million, fully laminar flow seems to predominate. Tip recession from ablation was also measured and found to agree reasonably well with theory. These and various other surface features are described and related to the model–material properties and to the flight environment. Author

N67-37540# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Labs.
THERMAL RADIATION PHENOMENA. VOLUME 3: TABLES OF RADIATIVE PROPERTIES OF AIR
May 1967 638 p refs
(DASA-1971-3; Rept.-3-27-67-1, Vol. 3; AD-654773)

This volume presents tables of the equilibrium radiative properties of air and its constituents for a wide range of temperatures and densities. The information contained in such tables is of necessity a combination of experimental fact and theoretical computation. The work is divided into five parts: Part A is a summary section designed to give an overview of the field. Some of the data are presented in semi-schematic form and should not be used for quantitative work. Part B gives basic data and references used in the preparation of the subsequent parts. Finally, parts C, D and E contain the absorption coefficients in the ranges 1000K to 24,000K (Part C), 1 eV to 20 eV(Part D), and above 20 eV(Part E). Author (TAB)

N67-37553# Naval Ordnance Lab., White Oak, Md.
ON THE DIFFERENTIAL EQUATION APPROXIMATION IN RADIATIVE GAS DYNAMICS
Shan Fu Shen 15 May 1967 49 p refs *Its* Aerodyn. Res. Rept.-282
(NOLTR-67-23; AD-655813)

A differential approximation for radiative transport is obtained which leads to a radiation term of the same order as the conduction term in the gas dynamic energy equation. It may be used to

generate radiative energy flux and boundary conditions. As a demonstration, the plane-parallel Milne problem is worked out. Author (TAB)

N67-37556# Bell Aerosystems Co., Buffalo, N. Y.
THERMAL RADIATION OF HIGH-TEMPERATURE COMBUSTION PRODUCTS Final Technical Report, 1 Jan. 1965–29 Jul. 1966
Theodor G. Rossmann and Leroy M. Wood Jan. 1967 236 p refs
(Contracts AF 49(638)-1498; AF 49(638)-1287)
(AFOSR-67-0951; Rept.-9139-933003; AD-656775)

An experimental program was initiated in an effort to amplify the scarce existing information concerning those physical properties of gases which determine their thermal radiation at high temperatures and elevated pressures. Well-known methods of quantitative spectroscopy were used for this purpose. Experimental methods were developed for producing the test gas in a certain zone in a flame burning in an inert gas, the pressure of which would be varied within certain limits. The experimental technique was developed at atmospheric pressure in order to keep to a minimum the experimental difficulties. A water cooled multihole burner with a radiating path length of 11 cm was developed. The burner, when fed by premixed oxygen and acetylene at the proper mixture ratio and surrounded by a high velocity shield of nitrogen gas, contained a test zone where CO was the only radiating component of the 3100K combustion products. The evaluation of the radiation measurements conducted on the test zone showed that successful techniques were developed for producing and isolating from the surrounding environment a uniform high temperature test gas. A thorough analysis was conducted concerning the reliability of the approximate measurements of the radiative properties of gases that must necessarily be obtained from a real spectrometer of limited sensitivity and resolution. Author (TAB)

N67-37579* Scientific Translation Service, La Canada, Calif.
SPECIFIC HEAT C_v IN THE COEXISTENCE REGION OF WATER [TEPLOYEMKOST' C_v V DVUKHFAZNOY OBLASTI PARAMETROV SOSYOUANIYA VODY]
V. V. Sychev Washington, NASA, Sep. 1967 9 p refs Transl. into ENGLISH from Inzh.-Fiz. Ah. (Moscow), v. 3, no. 7, 1960 p 10–16
(Contract NASw-1496)
(NASA-TT-F-11283) CSCL 20M

A rigorous and simple method is proposed for finding the fundamental relationships determining the laws of change of specific heat in the coexistence region of pure fluids. The specific heats of water on the coexistence curves in the temperature range from 0 to 340°C are calculated on the basis of available experimental data on calorific and thermal properties of water and water vapour. A comparison of calculation results with the available experimental data is given. Author

N67-37589# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.
THERMAL RADIATION PHENOMENA. VOLUME 1: THE EQUILIBRIUM THERMODYNAMIC PROPERTIES OF HIGH TEMPERATURE AIR
May 1967 340 p refs
(DASA-1971-1; Rept.-3-27-67-1, Vol. 1; AD-654054)

Contents: Air as a mixture of ideal gases in chemical equilibrium; Ideal gas properties for monatomic gases; Ideal gas properties for diatomic gases; Ideal gas properties for polyatomic gases; Effects of interparticle forces on the thermodynamic properties of air; Effects of Coulomb forces on the thermodynamic properties of air; Equilibrium calculations and results for air; Tables and graphs; Composition and properties of the atmosphere. TAB

N67-37590# Los Alamos Scientific Lab., N. Mex.
ORBITAL HEAT PIPE EXPERIMENT
J. E. Deverall, E. W. Salmi, and R. J. Knapp (Lockheed Missile and Space Co., Sunnyvale, Calif.) 22 Jun. 1967 14 p refs
(Contract W-7405-ENG-36)
(LA-3714) CFSTI: HC $3.00/MF $0.65

The "Grover Heat Pipe" is a self-contained, thermal conductance device which has no moving parts, utilizes the heat being transferred for its operation, has a thermal conductance higher than any known material, and conducts heat with essentially no temperature difference. Heat is transferred by means of mass flow of a fluid utilizing the latent heat of a two-phase system. The proper functioning of a heat pipe in a zero gravity field is described. A water heat pipe, 12-in. long and 3/4-in. OD, was operated in an earth orbit and its performance monitored by telemetry at several tracking stations during 14 revolutions. Results indicate that there was no degradation of heat pipe performance in a zero gravity field as compared to the performance in laboratory tests. Author (NSA)

N67-37600* Scientific Translation Service, La Canada, Calif.
INVESTIGATION OF THE EFFICIENCY OF A HEAT SHIELD OVER A PLANE SURFACE DURING INJECTION THROUGH TWO TANGENTIAL SLOTS [DOSLIDZHENNYA EFEKTIVNOSTI TEPLOVOY ZAVICI NAD PLOSKOYU POVERKHNEYU PRI VDUVANNI KRIZ' DVI TANGENTSIAL'NI SCHHILINI]
V. M. Repukhov and O. A. Bogachuk-Kozachuk Washington, NASA, Aug. 1967 6 p refs Transl. into ENGLISH from Dopovidi Akad. Nauk RSR, Ser. A, Fiz.-Tekhn. ta Mat. Nauki (USSR), v. 29, no. 2, 1967 p 180–183
(Contract NASw-1496)
(NASA-TT-F-11178) CSCL 20M

Results of wind tunnel studies of a heat shield over a plane surface with film cooling through two tangential slots are given. It is shown that in the turbulent main flow the efficiency behind the second slot (downstream) greatly depends on the operating conditions of the first slot, while the converse effect may be neglected. By taking into account the dynamic and heat boundary layer before the second slot, it is possible to correlate the efficiency data with each other and with data concerning the efficiency of a single slot. Author

N67-37613# Deutsche Versuchsanstalt fur Luft und Raumfahrt, Porz (West Germany). Institut fuer Angewandte Gasdynamik.
HYPERSONIC INVESTIGATIONS OF THE LOCAL AND AVERAGE HEAT TRANSFER IN CAVITIES AND AFTER STEPS OF BODIES OF REVOLUTION
W. Wyborny, H.-P. Kabelitz, and H.-J. Schepers *In* GARD Fluid Phys. of Hypersonic Wakes, Vol. 1 May 1967 34 p refs Sponsored by Deut. Ges. Fuer Flugwiss. (See N67-37601 22-12)

In axisymmetric cavities and after steps of bodies of revolution, measurements of heat transfer and pressure were made at Mach numbers as high as 16 and at varying Reynolds numbers. The heat transfer tests, made by a thin film calorimeter method, concern local as well as average heat transfer rates. By optical observation, detailed results on the flow behavior was gained. The measurements were made in the DVL-gun tunnel. The results are compared with theoretical solutions. Author

N67-37618*# Spectrolab, Inc., Sylmar, Calif.
ANALYTICAL, EXPERIMENTAL AND DEVELOPMENTAL WORK FOR A RADIATIVE HEATING SYSTEM. VOLUME II Final Report
[1967] 313 p
(Contract NAS2-1620)
(NASA-CR-73133; FR-6002, Vol. II) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The development of a high power plasma radiation source is described, including analytical studies and experimental results. A 60 kW-rated lamp was developed as a prototype for the final 150 kW lamp and to test a prototype optical system. The lamp used a double concentric envelope design with a tungsten cathode and a hollow bore anode. The main effort in the 60 kW lamp development was in anode design. The final anode was made of copper with a tungsten sleeve press fit into the inside diameter of the bore. An experimental radiation source was constructed to permit an orderly upgrading of the 60 kW prototype source to the specified 150 kW power input level. This source was designed to accommodate three different-size inner quartz envelopes and four different-size electrode pairs. A solid anode configuration was conceived and tested and proved to be superior to the bore type anode previously employed. Operation at 150 kW with 30% efficiency was achieved with the experimental unit. The final radiation source design contained a solid anode and employed a cantilevered self-supporting outer quartz envelope; satisfactory performance was obtained during continuous operation for two hours at current levels up to 1600 Å and in 25 intermittent tests of 15-minute duration. Input gas pressures were as high as 290 psi. Details of the novel anode design in the final radiation source are given. K.W.

N67-37662# Aeronautical Research Inst. of Sweden, Stockholm.
HEAT TRANSFER MEASUREMENTS AT M = 7.17—FIRST STEP OF A COMPARISON BETWEEN TUNNEL TEST AND FREE FLIGHT
H. Thomann Feb. 1967 14 p refs
(FFA-110) CFSTI: HC $3.00/MF $0.65

A paraboloid free flight model was designed, built and instrumented at the Royal Aircraft Establishment (RAE) in Farnborough. Prior to the flight, this model was tested in the hypersonic tunnel Hyp 500 at the Aeronautical Research Institute of Sweden (FFA). The model was designed to have uniform wall temperature during the test. As the same model is used in both tests and as the Mach number, the Reynolds number and the ratio wall temperature to free stream temperature are very nearly the same in both cases, the tunnel tests are an almost perfect simulation of the flight test. In the present paper, the tunnel tests (heat transfer and pressure distribution) are presented and compared with theory. Excellent reproducibility and good agreement with theory were found. The flight tests are planned to take place during the summer of 1967. Author

N67-37695# Los Alamos Scientific Lab., N. Mex.
OSCILLATIONS IN FLOWING AND HEATED SUBCRITICAL HYDROGEN
John D. Rogers [1966] 22 p refs Presented at the Cryog. Eng. Conf., Palo Alto, Calif.
(Contract W-7405-ENG-36)
(LA-DC-8726; CONF-670801-2) CFSTI: HC $3.00/MF $0.65

A hydrogen system in the lower, subcritical pressure range was studied to observe the threshold for transition from stable to unstable flow with heat addition. Sensitive temperature and pressure detectors and photographic observation provided data which can be readily correlated in terms of recent density variation theory. Steady oscillations in the unstable state are associated with the onset of vapor formation and at high heat rates with large pressure oscillations are characterized by vapor nucleation delays or subcooling just prior to the vapor formation and by bubble collapse rates. Author (NSA)

N67-37720# California Univ., Livermore. Lawrence Radiation Lab.
THE "LONG JOHN" THERMO-GASDYNAMIC RESEARCH PROJECT Summary Report
J. H. Pitts and J. H. Van Sant 11 Apr. 1967 24 p refs
(Contract W-7405-ENG-48)
(UCID-15130) CFSTI: HC $3.00/MF $0.65

Accomplishments of a 5-year-long thermo-gasdynamic research program have included the construction of a unique working experimental facility, development of test-section manufacturing procedures and necessary data-reduction techniques, and experimental operation during which more than 90 adiabatic flow tests were performed. The experimental facility was designed so that highly accurate data could be obtained with flow channels of various lengths and shapes over a large range of pressures, temperatures, and flow rates. The program permitted the development of several data-reduction techniques and verification of the Karman–Nikuradse correlation of adiabatic friction factor (developed with water) for air at high Reynolds numbers. Author (NSA)

N67-37722# Brookhaven National Lab., Upton, N. Y.
RECENT DATA ON HEAT TRANSFER IN A TURBULENT FLOW OF LIQUID DROPS IN ROUND TUBES
V. I. Subbotin and A. K. Papovyants Apr. 1967 22 p refs Transl. into ENGLISH from paper presented at IAEA Symp. on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, 29 Nov.–2 Dec. 1966
(BNL-TR-144; CONF-661110-35) CFSTI: HC $3.00/MF $0.65

Various methods for calculation of heat transfer coefficients are presented based on recent data concerning turbulent flow of liquid drops and gases in round tubes. Various values of Nusselt numbers for different Reynolds and Prandtl numbers are compared from the methods of Petukhov and Popov, Osmatchkin, Sparrow, Deissler, and Buleev. The Reynolds and Prandtl numbers are also compared with the length of hydraulic stability for distilled water and oil and stainless steel and nickel using the methods of Allen and Eckert, Malina and Sparrow, and Dipprey and Sabersky. NSA

N67-37861# Oak Ridge National Lab., Tenn.
INCIPIENT AND STABLE BOILING SUPERHEAT FOR POTASSIUM BOILING ON A SURFACE CONTAINING REENTRANT CAVITIES
J. A. Edwards (North Carolina State Coll.) and H. W. Hoffman [1966] 12 p refs Presented at the Semiintern. Symp. of Mech. Engr., Tokyo
(Contract W-7405-ENG-26)
(ORNL-P-3083; CONF-670909-1) CFSTI: HC $3.00/MF $0.65

The experimental aspects of heat transfer with boiling potassium on a stainless steel surface containing reentrant cavities are presented. The dependence of superheat on heat flux for both the stable boiling and bubble nucleation modes is also shown. The experimental results show: the reentrant cavities reduce the stable boiling superheat needed to boil potassium; incipient boiling is more apt to occur at small vapor pressures; incipient boiling superheat does not show any definite dependence on heat flux; and the magnitude of the stable boiling superheat is related to cavity size and heat flux. NSA

N67-37862# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
A REVIEW AND DISCUSSION OF LITERATURE CONCERNING TRANSIENT HEAT TRANSFER AND STEAM FORMATION
Robert P. Morgan Mar. 1967 70 p refs
(Contract AT(10-1)-205)
(IDO-17226) CFSTI: HC $3.00/MF $0.65

A review of experimental and theoretical information relevant to the prediction of forced-convection coolant behavior in subcooled water-reactor transients is presented. Emphasis is placed upon the determination of transient subcooled void fractions and the

description of transient heat transfer from fuel element surfaces to the coolant under both boiling and nonboiling situations. A number of recommendations for improving existing reactor-transient computer programs are made. Among these are a quasi-steady method for predicting the fraction of the surface heat flux which is utilized in void volume production in the slightly subcooled nucleate boiling region and a semiempirical equation for predicting transient void fractions. In general, it has been concluded that a complete and reliable analytical description of reactor coolant transient behavior is not presently possible, primarily because of uncertainties concerning the validity of quasi-steady methods during rapid transients and because of a lack of fundamental knowledge at the point of departure from nucleate boiling and beyond. Detailed analysis of recent in-pile and out-of-pile transient data, however, should lead to a better understanding of coolant behavior during subcooled transients. Author (NSA)

N67-37886*# Dynamic Science Corp., South Pasadena, Calif.
STUDY OF RANDOM WAVE PHENOMENA IN HYPERGOLIC PROPELLANT COMBUSTION
E. W. Nadig, E. A. Tkachenko, and B. P. Breen 30 Jun. 1967 71 p refs
(Contract NAS7-467)
(NASA-CR-88865; SN-87) CFSTI: HC $3.00/MF $0.65 CSCL 21B

High amplitude pressure waves (pressure spikes) associated with vacuum engine starting transients, and pressure pulses (pops) occurring during steady state operation of hyperbolic liquid rocket engines can be totally or partly detrimental to the rocket engine. The purpose of this research is to describe the conditions which, if present in a rocket combustion chamber during starting transient and during steady operation, will produce the observed pressure disturbances. Thus, the mechanism by means of which pressure spikes and pops develop are studied, however, the definition and verification of the pressure spike mechanism is emphasized. Both theoretical studies and laboratory experiments are utilized to accomplish this end. A detailed model is being developed which interrelates equations involving: (1) transient flow rate, (2) chamber pressurization, (3) preignition chemistry and delay, and (4) detonation processes. The model will determine conditions which exist in the chamber until ignition and, ideally, will quantitatively predict the magnitude and time of occurrence of the overpressure. To date, certain of the individual system processes of the model have been formulated and their solution has been obtained with the aid of a digital computer, whereas other processes still require additional analysis and experimentation. Author

N67-37898# North Carolina State Coll., Raleigh.
A STUDY OF THE OPERATING CHARACTERISTICS OF THE HEAT PIPE Quarterly Progress Report, 1 Oct.–31 Dec. 1966
J. D. Ferrell and A. Carnesale 1 Feb. 1967 30 p ref
(Contract AT(40-1)-3411)
(TID-23809; QPR-6) CFSTI: HC $3.00/MF $0.65

The operating characteristics of a stainless steel heat pipe are described along with an analytical model for predicting operating limits of capillarity-limited heat pipes. A continued analysis of a transient capillary rise model was performed along with comparisons with experimental data. Analysis of basic capillarity phenomena was continued, including determination of meniscus shapes under various conditions. NSA

N67-37918 Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
TEMPERATURE PROBE FOR HIGH ENTHALPY DISCHARGE [SONDE DE TEMPERATURE POUR ECOULEMENT A HAUTE ENTHALPIE]
Daniel Gautrot 1967 15 p refs In FRENCH Presented at the 30th Reunion of the Propulsion and Energy Group of AGARD on New Experimental Techniques, Munich, 11–15 Sep. 1967
(ONERA-TP-484/1967)

Thermocouple response in the determination of high gas temperatures up to 3000°C is briefly described. The high enthalpy gas flow was studied by the temperature measurement technique which is illustrated by pertinent equations and graphics. R.Li.

N67-37920# Aerotherm Corp., Palo Alto, Calif.
A STUDY OF THE BEHAVIOR OF SMALL SPHERES DURING REENTRY
Raymond E. Lundberg, William C. Reynolds, and Roald A. Rindal Jun. 1967 99 p refs Sponsored by AEC Prepared for Sandia Corp., Albuquerque, N. Mex.
(SC-CR-67-2635) CFSTI: HC $3.00/MF $0.65

The dynamic behavior during reentry of plutonium dioxide microspheres ranging in diameter between 50 and 250 microns is examined. The reentry trajectories, aerodynamic heating, and particle heating and melting are examined. The conditions for which wholly liquid droplets may shatter are examined. A method to describe the instability of a thin liquid layer on a solid substrate which experiences the complex reentry phenomena of deceleration, shear pressure and drag forces is presented. Particles of this diameter released at altitudes between 120,000 and 250,000 feet at velocities between 15,000 and 25,000 feet per second are shown to melt and in most cases the liquid layer is calculated to be unstable. Author (NSA)

N67-37975* Northwestern Univ., Evanston, Ill.
ESTABLISHMENT OF THERMODYNAMIC AND TRANSPORT PROPERTIES FOR PARA-HYDROGEN Final Report, 1 Sep. 1963–31 Aug. 1967
31 Aug. 1967 28 p refs
(Grant NsG-405)
(NASA-CR-88857) CSCL 20M

Published experimental information, particularly that of the National Bureau of Standards, was used to construct reduced density plots for para-hydrogen. These data with the atmospheric pressure heat capacity line permitted the establishment of enthalpy and entropy charts for para hydrogen. A reduced viscosity correlation for the gaseous and liquid states at cryogenic conditions was produced; and this correlation was used with data for normal hydrogen to generate a reduced viscosity correlation applicable to higher temperatures and pressures. Transport properties were predicted using the theoretical approach of enskog, and viscosity and diffusivity estimates were also made. Details are included for the prediction of pressure dependence on transport properties of gases, according to the Enskog method. M.W.R.

N67-37980# Los Alamos Scientific Lab., N. Mex.
A STUDY OF A SINGULARITY OF THERMODYNAMIC QUANTITIES AT THE LIQUID–VAPOR CRITICAL POINT OF A PURE SUBSTANCE
A. V. Vornel' (Ph.D. Thesis) 1966 19 p refs Transl. into ENGLISH from Russian Thesis
(LA-tr-68-79) CFSTI: HC $3.00/MF $0.65

Measurements of the heat capacity as a function of temperature and density were made in the vicinity of critical points of argon, nitrogen, and oxygen in the region of homogeneous and two-phase states. Measurement data of more than 1000 points for these substances and several mixtures are presented. The measurement data are indicative of the presence in the critical point of all pure substances of the characteristic of the heat capacity as to T and V being contrary to the existing theory of critical phenomena. NSA

N67-38004* Scientific Translation Service, La Canada, Calif.
THERMODYNAMIC CONSIDERATION OF BINARY VAPOR LIQUID EQUILIBRIA
Shuzo Ohe Washington, NASA, Sep. 1967 4 p refs Transl. into ENGLISH from Kagaku Kogyo (Tokyo), v. 31, no. 3, 1967 p 293–294
(Contract NASw-1496)
(NASA-TT-F-11265) CSCL 20M

A thermodynamic analysis of binary vapor liquid equilibria is presented. The excess partial molar free energy is computed and shown to be a maximum under certain conditions. Author

N67-38006# Aerojet-General Nucleonics, San Ramon, Calif. Nuclear Products and Services Group.
ALKALI METALS EVALUATION PROGRAM Quarterly Progress Report, 1 Jan.–31 Mar. 1967
P. Y. Achener May 1967 30 p refs
(Contract AT(04-3)-368)
(AGN-8222) CFSTI: HC $3.00/MF $0.65

Developments in studies on the thermodynamic and transport properties of Rb, Cs, and K and thermodynamic and transport properties of alkali metals for heat pipe applications are described. Data are given on: PVT relations for K; vapor thermal conductivity of Rb; liquid viscosity of Li; and liquid thermal conductivity of Li and Na. NSA

N67-38037*# Oak Ridge National Lab., Tenn.
PRELIMINARY COLLATION OF THE THERMODYNAMIC AND TRANSPORT PROPERTIES OF CESIUM
H. W. Hoffman and T. T. Robin, Jr. Jun. 1967 66 p refs
(NASA Order W-12353; Contract W-7405-ENG-26)
(NASA-CR-88967; ORNL-TM-1755) CFSTI: HC $3.00/MF $0.65 CSCL 20M

A preliminary collation of the thermodynamic and transport properties of saturated liquid and vapor Cs and a convenient and consistent source of properties in the design and evaluation of power systems based on thermodynamic cycles involving Cs as the working fluid are presented. Included are the thermodynamic properties—physical constants and critical state conditions, sonic velocities, PVT relationships (vapor pressure, density, and compressibility), enthalpy, heat capacity, latent heat of vaporization, and entropy, and surface tension—and the transport properties—viscosity, thermal conductivity, and electrical resistivity. A preliminary evaluation of the data available indicates the need for additional measurements of both the thermodynamic and transport properties. Author (NSA)

N67-38040# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
OPTIMUM INPUT LEADS FOR CRYOGENIC APPARATUS [OPTIMISATION DES DESCENTES DE COURANT DANS DES ENCEINTES CRYOGENIQUES]
Gerard Der Nigohossian (Ph.D. Thesis) Feb. 1967 120 p refs In FRENCH
(CEA-R-3167)

The electrical leads used to introduce a current into a cryostate cause a heat influx due to thermal conduction and to Joule heating. It is important to be able to minimize this flux. Theoretical calculation of optimized leads takes into account the varying heat and electrical conductivities of the leads as well as the heat exchange coefficient with the effluent gas. Practical results are summarized in different tables which permit for a specific material i.e., copper, aluminium, brass, and stainless steel with the intensity and end temperatures being known (i.e., 4.2 or 18.5°K at the cold end and 77.295 or 320°K at the warm end) to deduce the minimum heat flow and the length-cross section ratio of the optimized leads. The solution of the problem using other materials is also presented. Author (NSA)

N67-38054*# West Virginia Univ., Morgantown. Dept. of Mechanical Engineering.
THERMAL CONTROL ASPECTS OF SPACECRAFT LOUVERS Annual Report
Jerome F. Parmer and David L. Buskirk [1965] 25 p refs
(Grant NGR-49-001-014)
(NASA-CR-88876) CSCL 20M

Described and analyzed is an internal louver system with the following characteristics: (1) an outer skin with low solar absorptance and high terrestrial emittance; (2) interior surfaces of the skin coated black and having high emittance; (3) highly polished louver blades of specular material having extremely low emittance; (4) blades as thin as practical; and (5) mounting plate emittance as high as possible. Heat balance, radiant properties, heat transfer, and thermal resistance of the system are mathematically analyzed, and heat input to an external louver system from a diffusely emitting surface is briefly examined. A description is also given of revised input and output of a digital computer program used in these analyses. K.W.

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N67-36751*# Indiana Univ., Bloomington. Aerospace Research Applications Center.
EXPERIMENTS IN TECHNOLOGY UTILIZATION, VOLUME II Quarterly Report, 1 May–31 Jul. 1967
Joseph DiSalvo 30 Aug. 1967 138 p refs
(Contract NSR-15-003-055)
(NASA-CR-88352) CSCL 05B

Standard interest profiles are given for scientists, engineers and management in the context of information distribution and current awareness programs. Descriptions and sample output of standard interest profiles are presented along with a guide to their use. Exhibits relative to management science and research in automatic maintenance of current awareness profiles is also covered. C.L.W.

N67-36919# Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
OPTIMUM ALLOCATION OF TRANSPORTATION TERMINALS IN URBAN AREAS
Barton Emmet Cramer 1 Nov. 1966 63 p refs
(Contract C-85-65)
(R66-60; PB-173684)

This study sought to find a method of determining the location of a number of transportation terminals in an urban area that were most accessible, and had the greatest utility from a system customer's point of view. Efforts focused on a homogeneous, or continuously distributed model, hoping to get some additional insight into the nature and behavior of the problem. By equating demand distribution with population distribution, and making some straightforward assumptions about travel velocity and path, a simple circular model was constructed. Results showed that the optima are quite insensitive, permitting considerable freedom in

determining exact final terminal locations. With two or more stations, accessibility is greatly improved in terms of the average travel time, the maximum travel time, and the variance of the travel time. The model generates solutions which compare favorably with more complex models. Author

N67-36954# Institut za Nuklearne Nauke (Boris Kidric), Belgrade (Yugoslavia).
BULLETIN OF THE BORIS KIDRIC INSTITUTE OF NUCLEAR SCIENCES, VOLUME 17, NUMBER 2 [BILTEN INSTITUTA ZA NUKLEARNE NAUKE "BORIS KIDRIC"]
1966 88 p refs Published for AEC and NSF
(AEC-TR-6646/2)

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1. RADIATION DAMAGE IN STEEL WITH MEDIUM AND HIGH CARBON CONTENT S. R. Veljkovic, A. Scepanovic, and V. Stefanovic p 77–88 refs (See N67-36955 22-17)

2. SURFACE WAVE MEASUREMENTS ON THE POSITIVE COLUMN OF A MERCURY VAPOR ARC B. A. Anicin p 89–96 refs (See N67-36956 22-25)

3. A STANDARD GRAPHITE BLOCK M. Ivkovic, Z. Zdravkovic, and O. Sotic p 97–112 refs (See N67-36957 22-22)

4. TALC DEHYDRATION KINETICS S. Boskovic, M. Gasic, B. Zivanovic, and M. M. Ristic p 113–124 refs (See N67-36958 22-06)

5. THERMODYNAMIC CHARACTERISTICS OF SELF-DIFFUSION IN α-URANIUM D. Cerovic, A. Mihajlovic, and M. M. Ristic p 145–147 refs (See N67-36959 22-33)

6. THERMODYNAMIC ASPECTS OF B. PINES SINTERING KINETICS V. Mikijelj and M. M. Ristic p 148–151 refs (See N67-36960 22-33)

7. A PRACTICAL LABORATORY COLD BOX FOR USE IN BIOCHEMICAL INVESTIGATIONS FROM +4° TO −15°C M. Milosevic p 152–154 refs (See N67-36961 22-11)

N67-37098# Information Dynamics Corp., Reading, Mass.
SELECTIVE DISSEMINATION OF INFORMATION (SDI). VOLUME I: PILOT TEST AT U.S. ARMY NATICK LABORATORIES
William A. Bivona 14 May 1967 97 p
(Contract DA-19-129-AMC-957(N))
(IDC-8074-2; Rept.-15; AD-654997)

The report presents the results of a nine-month test of a prototype SDI system developed for Army Technical Libraries. During the pilot test, one thousand documents were cataloged and indexed and disseminated to twenty-five scientific and technical personnel at U.S. Army Natick Laboratories. During the course of the pilot test, statistics were accumulated on operating costs and various parameters affecting the relevancy of disseminated information. The prototype SDI system utilizes graphic techniques for producing multiple copies of each document abstract. The output of the computerized matching function is a set of EAM cards which are subsequently used to collate reproduced abstracts for dissemination. Collation is accomplished by interspersed gangpunching, merging, and sorting techniques. Author (TAB)

N67-37187# Analytic Services Inc., Baileys Crossroads, Va.
INDUSTRIAL-LOCATION THEORY IN THE ERA OF SUPER-CARGO AIRCRAFT
Irving Casey Aug. 1967 29 p refs
(AD-655695)

The report surveys classical theories of industry location and appraises their applicability in the 1970s, when very large cargo aircraft are expected to be introduced. Modifications of existing theory are considered toward the development of an extended general theory of location. Some preliminary observations are made on the effects of super-cargo aircraft on industry location. The study is one product of a program of private, self-sponsored research. The program has the objective of examining changes in industry location that could result from introduction of super-cargo aircraft such as the planned Boeing 747 subsonic jet transport.
Author (TAB)

N67-37249*# Washington Univ., St. Louis, Mo.
THE MILITARY/SPACE MARKET: THE INTERSECTION OF THE PUBLIC AND PRIVATE SECTORS
Murray L. Weidenbaum Sep. 1967 79 p refs Working Paper 6712
(Grant NsG-342)
(NASA-CR-88699) CSCL 05A

The nature of the military and space market in the United States; the customers; the sellers; price formation and competition; specialized contractors; and the changing nature of the contractors, are discussed. L.S.

N67-37292# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SPACE AND THE PROBLEM OF UNIVERSAL PEACE
G. P. Zhukov, E. G. Vasilevskaya, and P. I. Lukin 27 Apr. 1967 178 p refs Transl. into ENGLISH of the book "Kosmos i Problema Vseobshchego Mira" Moscow, 1966 p 1–195
(FTD-MT-66-154; TT-67-62379; AD-655366)

At the experimental stage of using communication satellites and meteorological observations with the help of satellites, international collaboration is directed by decisions of international organizations, and is regulated by bilateral and multilateral international agreements. From that moment when two or more competing systems of world-wide communication are created, with the appearance in the sky of meteorological satellites of various countries, a vital necessity will appear for clearly developed international legal tools. International legal science is already being called now to work out just and expedient solutions which will be incorporated in international agreements. TAB

N67-37324# Information Dynamics Corp., Reading, Mass.
SELECTIVE DISSEMINATION OF INFORMATION (SDI). VOLUME II: IMPLEMENTATION MANUAL
William A. Bivona 13 Jun. 1967 124 p
(Contract DA-19-129-AMC-957(N))
(IDC-8074-3; Rept.-16; AD-654998)

The document is a manual and set of guidelines for implementing and operating a replica of a prototype SDI system tested at U. S. Army Natick Laboratories. It supplies information which is especially useful in the initial stages of implementation. It discusses the application of specific criteria for selecting an initial set of participants in the SDI program and gives guidelines for analyzing document input, indexing vocabulary and internally and externally produced machine-readable records that might be used as preferential or additional input. Two sections of the manual are devoted to giving specific directions to library and data processing personnel which are necessary for operation of the SDI system.
Author (TAB)

N67-37341# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
EFFECTIVENESS OF INFORMATION RETRIEVAL METHODS
John A. Swets 15 Jun. 1967 52 p refs
(Contract AF 19(628)-5065; ARPA Order 627)
(AFCRL-67-0412; SR-8; AD-656340)

Results of some fifty different retrieval methods applied in three experimental retrieval systems were subjected to the

analysis suggested by statistical decision theory. The analysis validates a previously-proposed measure of effectiveness and demonstrates its several desirable properties. The examination of a wide range of data in relation to this one metric provides a clear and general assessment of the current state of the retrieval art, and shows that the art is still far from what might be considered a desirable state. Author (TAB)

N67-37466# Naval Oceanographic Office, Washington, D. C.
AUTOMATION OF UNDERSEA FEATURE NAMES
M. Karl Jugel Jun. 1967 25 p Presented at the Am. Congr. Conv. on Surv. and Mapping, Washington, D. C., 10 Mar. 1967
(IR-67-13; AD-655449)

During 1964 the Bathymetry Division of the Hydrographic Surveys Department, U. S. Naval Oceanographic Office, established three Hollerith card files for undersea feature information. One file, converted to magnetic tape in July 1966, contains alphabetical undersea names, another the locations and other pertinent information on named and unnamed minor features (seamounts, etc.) and the third, information on major features. The files contain the actions of the Advisory Committee on Undersea Features of the Board on Geographic Names, and are used to implement their actions in the U. S. Naval Oceanographic Offices Bottom Contour Chart Program and in various special studies. A comprehensive automated system using modifications of these three files to facilitate the preparation of Bottom Contour and other charts and studies is given. The system can be used to give a contourer advanced information on critical features of interest in the area being analyzed and hopefully improve the accuracy and quality of contours. TAB

N67-37784* Washington Univ., St. Louis, Mo.
[ANALYSES OF THE IMPACT OF SPACE ACTIVITIES ON THE NATIONAL ECONOMY, AND ESTABLISHMENT OF A METHODOLOGY FOR DETERMINING SPACE PROGRAM EFFECTS ON REGIONAL ECONOMIC GROWTH] Progress Report, 15 Mar.–15 Sep. 1967
Murray L. Weidenbaum 15 Sep. 1967 151 p refs
(Grants NsG-342; NSF G-22296)
(NASA-CR-88486; PR-8) CSCL 05A

Based on an analysis of NASA 1st and 2nd tier subcontract activities, a forecasting model is designed to provide first approximations of the geographic distribution of subcontract awards. In one approach, multiple regression equations were developed based on each state's share of the subcontract awards (dependent variable), and its corresponding share of total United States technical personnel and key industry employment (independent variables). A regional approach was considered based on differences in technical and industrial emphasis of subcontract procurement resulting from different prime activities. By categorizing prime contracts on the basis of their contract activities, fairly stable 1st tier subcontract distribution patterns on the Northeast, Pacific, and East North Central regions are developed. It is concluded that the 1st and 2nd tier subcontract programs provide a wider and less concentrated distribution of NASA dollars, particularly at the state level. However, the extent of the redistribution, as reflected by the total net distribution of prime awards, is only of marginal significance at the more aggregate regional level. M.G.J.

N67-37785# Congress. House. Committee on Appropriations.
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION APPROPRIATIONS FOR 1968
Washington, GPO, 1967 63 p Additional Hearings before a Subcomm. of the Comm. on Appropriations, 90th Congr., 1st Sess., 15 Aug. 1967

Additional hearings on 1968 appropriations for NASA are reprinted in this report of the Subcommittee on Independent Offices and Department of Housing and Urban Development of the House of Representatives Committee on Appropriations. A summary of the Apollo program and future Apollo efforts are included; along with manned flight tests for the next year, flight testing and schedules, the impact of the Apollo fire, and Soviet space programs, and other space programs. M.W.R.

N67-37818*# National Aeronautics and Space Administration, Washington, D. C.
NASA SPACE SCIENCE PROGRAM
John E. Naugle *In* ESRO *Plasmas in Space and in the Lab.* Apr. 1967 p 19–62 (See N67-37816 22-25)

The major objectives of the Office of Space Science are reviewed. They contain programs to study solar physics and the effects of solar radiation on the earth and to explore the properties of the moon; a planetary program; one of astronomy and finally a program to use this knowledge and technology developed for the space program for the practical benefit of mankind. Emphasis is made on the study of the sun and the properties of the magnetosphere, ionosphere, atmosphere, and interplanetary space. ESRO

N67-37846* Washington Univ., St. Louis, Mo. Dept. of Economics.
AN ECONOMIC ANALYSIS OF RESEARCH AND DEVELOPMENT PROCUREMENT: THE NASA SUBCONTRACT PROGRAM
John T. Burgess Jul. 1967 171 p refs *Its* Working Paper 6078
(Grant NsG-342)
(NASA-CR-86846) CSCL 05C

The size and geographic distribution of NASA 1st and 2nd tier subcontract activity and the economic factors affecting the distribution are investigated. It was found that the greater the degree of complexity and R & D work involved, the greater the tendency is for the work to be performed in complexes. On the other hand, when considerable subcontract activities are required, the subcontracts gravitate to areas having a greater concentration of specialization needed. Establishment rather than product basis is used to provide an industrial classification of subcontract work. Industrial orientation and geographic distribution are discussed with respect to subsystem, nonsubsystem, and 2nd tier procurement. A basis for first approximation forecasts of the size and geographic distribution of 1st and 2nd tier subcontract is presented, emphasizing the selection of appropriate variables. N.E.N.

N67-38038# Western Reserve Univ., Cleveland, Ohio. Center for Documentation and Communication Research.
AUTOMATIC PROCESSING OF METALLURGICAL ABSTRACTS FOR THE PURPOSE OF INFORMATION RETRIEVAL Final Report
Jessica S. Melton 1 Jul. 1967 28 p refs Prepared for NSF
(NSF-4)

The test corpus consisted of 768 abstracts from the metallurgical section of *Chemical Abstracts (CA)*. The system, based on a subject indexing rationale, had two components: (1) a stored dictionary of words classed according to their subject content rather than their grammatical class membership; and (2) a set of stored rules applied to the text on a sentence-by-sentence basis to structure each sentence as a tree structure designating its subject content. Search strategies were formulated on the basis of the structure of the file, and programs were written to trace the words of the search through the tree structure. It was found that: (1) sentence-by-sentence scanning of the text of *CA* yields by far too many retrievals; and (2) that the structuring of the file does not make an appreciable difference in the search results (reducing

the retrievals by only 17%). Both of these findings are directly relevant to any system of processing text by computer for document retrieval. They also have less direct implications as to the justification of other syntax-like devices, such as role indicators, in a document retrieval system. The necessity of comparing the performance of automated text-scanning systems to actual operational systems is stressed and a design for further experiments is proposed. Author

N67-38057* Indiana Univ., Bloomington. Aerospace Research Applications Center.

[EXPERIMENT IN THE DECENTRALIZED REPRODUCTION AND PROVISION OF HARD-COPY DOCUMENTS OF AEROSPACE GENERATED TECHNOLOGY CONTAINED IN THE NASA INFORMATION RESOURCES] Quarterly Report, Jun. 8–Aug. 31, 1967

Virgil E. Bradford 8 Sep. 1967 34 p

(Contract NSR-15-003-054)

(NASA-CR-88551) CSCL 05B

A microcard EL-4 document copier was purchased and document reproduction was successfully initiated. Paper requirements, equipment performance, and user evaluation, and cost data for this equipment are presented. Also included is a sample of document reproduction capabilities. S.C.W.

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In addition, NASA regularly sends its publications to the Enoch Pratt Free Library located in Baltimore, Maryland and the Wilmington Institute Free Library, Wilmington, Delaware.

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—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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